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Production and oenological potential of Riesling variety clones 49, 1091 and 1089

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Abstract: Clonal selection in viticulture is based on genetic variability with the aim of creating superior plants (clones) that enable more economical production. The Riesling variety, with a long tradition of cultivation, has been the subject of extensive clonal selection and clones 49, 1089 and 1091 were created in France. During the two-year period (2016–2017), the productivity and oenological potential of Riesling clones 49, 1089 and 1091 in the agroclimatic conditions of Bosnia and Herzegovina were conducted. Significant differences between clones were found in the yield per vine (1.34–1.87 kg), ten skins weight (2.17–2.46 g) and mass of ten berries seeds (0.27–0.35 g). The highest soluble solids content was found in clone 49 (22% Brix). Significant variation in the content of total polyphenols in the grape skin was observed in clones 49 and 1091 during the research period, compared to clone 1089 where the differences were less pronounced. The tested clones statistically differed each other significantly in most of the tested wine characteristics, except for the content of volatile acids. Clone 49 had slightly better results in terms of yield indicators, as well as a more uniform yield compared to clones 1089 and 1091. The tested clones, grown in agroecological conditions of northwestern part of Bosnia and Herzegovina showed satisfactory results in terms of grape and wine quality, which do not lag the Riesling variety in terms of literary data.

Key words: Clone, yield, grape quality, wine characteristics

1. Introduction

Grapes are economically important fruit crops throughout the world. Mainly due to their high content of phenolic compounds, they provide potential benefits to human health (Fronk and Jaeckels, 2017). Moreover, phenolic compounds also affect sensory properties such as color, odor and taste of grapes and wine (Quideau et al., 2011). To establish a link between viticultural, climatic and soil parameters and wine composition, many studies have tried to classify white wines according to geographic origin (Fischer et al., 1999). Riesling is a variety that is characterized by long cultivation tradition, which has led to the emergence of great heterogeneity within the variety and the need for clonal selection. According to Haeger (2016) clonal selection of the Riesling variety began in Germany and then in France, California, and Austria. Genetic variability is the basis of clonal selection, which aims to eliminate the negative impact of mutations, propagation of plants infected with viruses and other diseases, in future vineyards (Mannini, 2000; Maletić et al., 2016; Golino et al., 2017) and create varieties that are in line with new market and environmental challenges (Werner and Kozma, 2012). Genetically inherited variability of vegetatively propagated plants, accumulation of favorable and unfavorable attributes is mainly due to bud mutations (Mullins et al., 1992). Over the last two decades, several researchers have dealt with the characteristics of the Riesling variety (Todić et al., 2000; Hristov, 2017), as well as its clonal selections (Pelsy et al., 2010; Jovanović-Cvetković et al., 2011; Stroe and Ioana, 2015). Clonal selection can increase the Riesling variety yield by up to 36% (Pejović and Maraš, 1994). Although the Riesling variety is grown in a wide geographical area, the variety typicality is perhaps best manifested in areas with temperate continental and continental climates. The subject of this research were clones of the Riesling variety, originating from the Alsace region (France) and are the result of a cloning selection program of the Riesling B variety, implemented by L'Institut National de la Recherche Agronomique (INRA) and Le Conseil Interprofessionnel des Vins d'Alsace (CIVA). The aim of the research was to assess the production and oenological potential of the studied clones in the conditions of the northwestern part of Bosnia and Herzegovina.

2. Material and methods

The field experiment was performed in 2016 and 2017 in the vineyard of the "Fazan" winery, which belongs to the Ukrina's vinegrowing region (44°89'44.42"N; 17°56'84.04"S). The characteristics of Riesling French

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clones 49, 1089 and 1091 were studied. The viticulture area, where the study was conducted, was created in 2008. Plant distance in vineyard is 3.0 × 1.0 m and training system is "Guyot" single. Mixed pruning was performed on 10 randomly selected vines—one fruiting cane with 10 buds and one renewal spur with 3 buds (a total load of 13 buds per vine).

Variable climatic conditions prevailed in the research period (Figure 1). Slightly higher air temperatures and lower precipitation amounts were recorded in 2017, which was therefore somewhat more favorable for wine production and protection against pathogens.

The harvest was performed at the time of optimal maturity for the tested clones and when the total soluble solid (TSS) content was between 20 and 22 Brix (BBCH 89 phase). The number of grape clusters was determined on ten grapevines of each studied clone. Individual clusters and mature grape berries of each clone were collected, counted, and weighed. Ten representative clusters from each treatment were selected. The number of grape berries per cluster was recorded at maturity. The mass of grapes in the cluster and the mass of an individual grape berry were measured with a digital scale (KERN 440, Germany). Afterwards, the seeds from each mature grape berry were extracted and washed to remove pulp. Mass of the total number of seeds of 10 berries was determined by measuring on a digital scale. Mechanical analysis was performed on grape cluster at optimal maturity (10 grape clusters and 100 grape berries). The yield per grapevine was based on the number of grape clusters and their average weight.

The basic parameters of grape juice quality were determined by analyzing the total soluble solids content-sugar (% Brix) in the juice, total titratable acids, and juice pH value. The sugar content was measured with a digital refractometer (Atago-Pal-3), while the total titrable acidity (g L^{-1} tartaric acid) was determined by acid neutralization method with 0.1 N NaOH solution. The pH value of grape juice was determined with a pH meter (Hanna HI2211). Sample preparation and analysis of total anthocyanins and polyphenols in grape skins and seeds was done according to the methods applied within the COST action FA1003 project "East-West Collaboration for Grapevine Diversity Exploration and Mobilization of Adaptive Traits for Breeding" (Di Stefano et al., 1989; Rustioni et al., 2014) spectrophotometrically (Spectrophotometer UV mini-1240, Shimadzu).

Grape microvinification of all three clones was carried out in the same way, according to the standard protocol for white wine production. The percentage of total soluble solids-sugar (% Brix TTS) was measured with a digital refractometer (Atago Pal-3), the must total titratable acidity (TTA) was determined by neutralizing acids with 0.1M NaOH (g tartaric acid/L), and the must pH was determined using a pH meter (Hanna HI 2211). Analyses of the basic characteristics of wine (alcohol content, sugarless extract, reducing sugars, total volatile acids, total acidity and pH of wine) were done after five months, by standard methods defined by the International Organization of Vine and Wine (OIV, 2012). Data was presented as descriptive measures for all studied characteristics in form of mean and standard error of the mean, i.e. $\bar{X} \pm S_{\bar{x}}$. Biometrical analysis was done by fitting general linear models. The observed difference was considered significant at level $p < 0.05$. Further multivariate analysis was conducted in form of principal components analysis where relationship in form of grouping and separation was analyzed both between studied characteristic and clones. Data analysis and graphical presentation was conducted with assistance

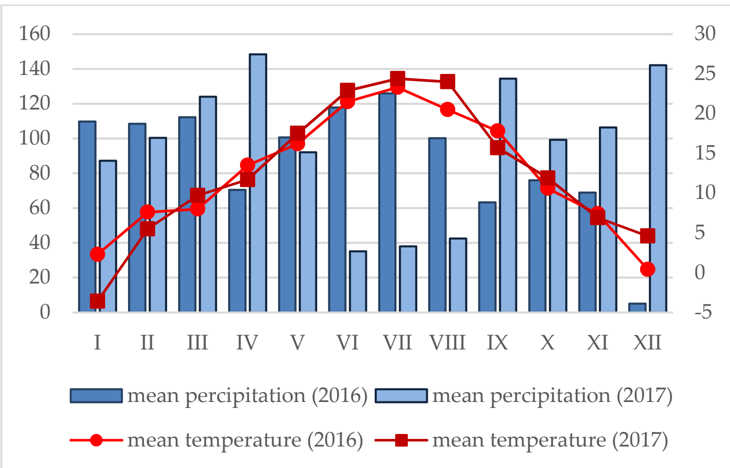

Figure 1. The average monthly temperatures (°C) and total precipitation (mm) during 2016–2017 period.

of statistical software package SPSS 22 (IBM Corporation, Armonk, NY, USA).

3. Results

3.1. Yield

The highest yield per grapevine was recorded in clone 1089 in 2016 (1.87 kg), while the lowest yield was registered in 2017 (1.34 kg) in the same clone (Table 1). Clone 49 had less fluctuations in yield during the study period compared to the other two clones. Apart from the year, the interaction between the year of research and the studied clones also had a statistically significant effect on the achieved yield. Clone 1089 had significant fluctuations in the grape cluster weight (Table 1) during the research period (85.71 g in 2017 and 131.76 g in 2016) which conditioned the statistical significance in the difference of this parameter in the research years. The other two clones had a relatively uniform cluster weight during the study period. The number of berries per cluster did not differ statistically significantly during the research period in the studied clones. All studied clones had larger berries during 2017 compared to 2016, which was reflected in the statistical significance of the differences. The weight of ten berries was uniform among the studied clones during 2017. The year had a statistically highly significant effect on the skin weight of ten berries, considering the established differences (Table 1).

3.2. Grape quality

The results of the analysis of the basic qualitative characteristics are given in Table 2. The highest soluble solids content was observed in clone 49 (22.00 % Brix) in 2016, while the lowest content was recorded in clone 1089 (19.77 % Brix) during the same year. Soluble solids content was quite uniform in clone 1091, in contrast to clones 49 and 1089, where certain variability in sugar content was observed. Clone 49 had a higher total acidity during both years of the study compared to the other two clones. Somewhat greater variation in total acidity during the years of research was registered in clone 1089.

3.3. Polyphenol content

Significant variation in the total polyphenols content the grape skin was found in clones 49 and 1091 in both years of research, compared to clone 1089 where the differences were less pronounced (Table 2). In 2016, clone 49 had the highest polyphenols content in the grape skin (845.57 mg kg^{-1}), in contrast to 2017 when the same clone and clone 1091 had a significantly lower content (480.32 mg kg^{-1}, or 480.31 mg kg^{-1}). Seeds also had uneven total polyphenols content. The highest content was recorded in clone 1091 in 2016 (526.34 mg kg^{-1}), and the lowest in clone 1089 in 2017 (305.51 mg kg^{-1}). The year had a statistically highly significant effect on pH, bearing in mind that in all tested clones, a higher value was recorded during 2016 compared to 2017.

3.4. Wine characteristics

The results of wine analysis are presented in Table 3. Statistical analysis of basic characteristics of wine indicates a statistically highly significant influence of clones on most tested characteristics, while highly significant influence of the year was shown in only certain characteristics (total acidity and pH of wine). Clone 49 stood out compared to other clones, in both research years based on better results of parameters that significantly affect the wine quality: alcohol content (13.27; 12.78% v/v), sugarless extract (18.15; 18.00 g L^{-1}) and total wine acidity (7.54; 6.87 g/L). The alcohol content in the wine of clones 1089 and 1091 (12.34 and 13.14% v/v, respectively 12.74 and 12.83% v/v) was lower compared to clone 49. The wine total acidity

Table 1. Yield per grapevine and cluster and grape berry characteristics of studied clones.

		Yield per vine [kg]	Cluster weight [g]	Berries [no.]	10 berries weight [g]	10 skins weight [g]	Mass of 10 berries seeds [g]
		$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$
Clone 49	2016	1.55 ± 0.10	99.95 ± 8.81	87.0 ± 4.97	13.68 ± 0.16	2.51 ± 0.08	0.27 ± 0.01
	2017	1.65 ± 0.10	104.68 ± 9.80	77.2 ± 5.91	16.96 ± 0.94	2.26 ± 0.07	0.32 ± 0.01
Clone 1089	2016	1.87 ± 0.13	131.76 ± 10.04	82.7 ± 4.99	15.87 ± 0.18	2.64 ± 0.09	0.33 ± 0.00
	2017	1.34 ± 0.10	85.71 ± 6.63	58.9 ± 4.53	16.21 ± 0.36	2.17 ± 0.07	0.35 ± 0.00
Clone 1091	2016	1.75 ± 0.13	106.3 ± 9.84	73.2 ± 4.80	15.37 ± 0.42	2.64 ± 0.09	0.38 ± 0.01
	2017	1.42 ± 0.14	94.44 ± 9.32	70.3 ± 5.72	16.96 ± 0.94	2.26 ± 0.07	0.32 ± 0.01
$F_{genotype}$, $p_{genotype}$		0.14; 0.986	0.46, p = 0.635	2.93, p = 0.062	3.67; 0.091	1.65; 0.269	57.57**; <0.001
F_{year}, p_{year}		7.01*; 0.011	5.6*, p = 0.021	8.29, p = 0.006	7.25*; 0.036	41.23**; <0.001	0.14; 0.718
$F_{gen.*year}$, $p_{gen*year}$		3.81*; 0.028	4.01*, p = 0.024	2.12, p = 0.131	4.91; 0.055	2.56; 0.157	51.57**; <0.001

Table 2. Grape quality of studied clones.

		Soluble solids content [% Brix]	TTA [g L^{-1}tart. ac.]	pH	Polyphenol content in skin [mg kg^{-1}]	Polyphenol content in seed [mg kg^{-1}]
		$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$
Clone 49	2016	22.00 ± 0.06	7.60 ± 0.03	3.05 ± 0. 06	845.57 ± 50.76	333.63 ± 44.81
	2017	20.77 ± 0.03	7.08 ± 0.08	2.81 ± 0.06	480.32 ± 39.79	443.88 ± 3.36
Clone 1089	2016	19.77 ± 0.03	7.06 ± 0.02	3.18 ± 0.06	515.41 ± 14.89	505.62 ± 73.84
	2017	21.23 ± 0.03	6.31 ± 0.02	2.89 ± 0.10	541.83 ± 18.00	305.51 ± 20.92
Clone 1091	2016	21.00 ± 0.06	6.65 ± 0.05	3.01 ± 0.05	734.36 ± 24.04	526.34 ± 70.94
	2017	21.07 ± 0.03	6.63 ± 0.03	2.88 ± 0.04	480.31 ± 39.79	458.88 ± 18.36
$F_{genotype}$, $p_{genotype}$		213.7**; <0.001	162.9**; <0.001	1.75; 0.215	5.53*; 0.044	2.81; 0.138
$F_{year,}$ p_{year}		8.1*; 0.015	144.5**; <0.001	18.04**; 0.001	50.33**; <0.001	1.86; 0.221
$F_{gen.*year}$, $p_{gen*year}$		492.3**; <0.001	37.32**; <0.001	0.81; 0.467	13.02**; 0.007	5.48*; 0.044

Table 3. Basic wine characteristics of studied clones.

		Alcohol content [% v/v]	Sugar-free extract [g L^{-1}]	Reducing sugars [g L^{-1}]	Total acidity [g L^{-1}tart. ac.]	Volatile acidity [g L^{-1}acet. ac.]	pH wine
		$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$
Clone 49	2016	13.27 ± 0.035	18.15 ± 0.040	1.65 ± 0.040	7.54 ± 0.006	0.25 ± 0.012	2.84 ± 0.012
	2017	12.78 ± 0.006	18.00 ± 0.023	0.70 ± 0.162	6.87 ± 0.006	0.50 ± 0.006	2.60 ± 0.006
Clone 1089	2016	12.34 ± 0.075	16.05 ± 0.121	0.70 ± 0.023	6.34 ± 0.035	0.20 ± 0.009	2.80 ± 0.012
	2017	13.14 ± 0.006	17.00 ± 0.023	1.50 ± 0.023	6.15 ± 0.023	0.56 ± 0.006	2.70 ± 0.006
Clone 1091	2016	12.74 ± 0.035	16.50 ± 0.242	1.20 ± 0.006	6.58 ± 0.017	0.26 ± 0.006	2.78 ± 0.012
	2017	12.83 ± 0.035	16.60 ± 0.023	1.90 ± 0.012	6.45 ± 0.023	0.52 ± 0.035	2.59 ± 0.006
$F_{genotype}$, $p_{genotype}$		19.78**; 0.002	82.24**; <0.001	16.41**; 0.004	1470.6**; <0.001	0.35; 0.715	15.36**; 0.004
$F_{year,}$ p_{year}		11.57*; 0.014	7.04*; 0.038	7.12*; 0.037	490.05**; <0.001	387.6**; <0.001	334.09**; <0.001
$F_{gen.*year}$, $p_{gen*year}$		87.69**; <0.001	8.67*; 0.017	68.18**; <0.001	131.4**; <0.001	4.61; 0.061	14.27**; 0.005

of the tested clones was in the range from 6.15 g/L (clone 1089 in 2017) to 7.54 g L^{-1} (clone 49 in 2016) but was lower in all clones in the second year of the study. The wine pH test results showed that the clone 1091 wine had the lowest value (2.59 in 2017), while the clone 49 wine had the highest value (2.84 in 2016). The wine volatile acidity of the tested clones ranged from 0.20 g L^{-1} to 0.56 g L^{-1}, and the content of reducing sugars in the wines of all clones ranged from 0.90 g L^{-1} to 1.90 g L^{-1}.

3.5. General analysis of characteristics and clones in study years

Studied characteristics were classified by principle components analysis (PCA) in order to observe grouping and separation patterns (Figure 2). PCA explained 78.31% of variation. The first principal component (PC1, 42.76% variation) is predominantly defined in positive direction by skin weight, pH of berries and wine, yield, cluster weight and number of berries per cluster. In negative direction it is defined by volatile acidity in wine. Principal component 2 (PC2, 35.55% variation) is predominantly defined in positive direction by Brix, polyphenol content in skin and alcohol content. In negative direction weight of berries and seeds and polyphenol content in seeds is what dominated second component. Grouping patterns are also visible in clones, as there is sharp separation between years of study along PC1. It is notable that the year was more influential than clone in general grouping. Acidity in berries and wines, yield and berry weight were the predominant factors in such a grouping.

4. Discussion

4.1. Yield

The grape yield depends on many production factors, among which the number of buds left after pruning directly

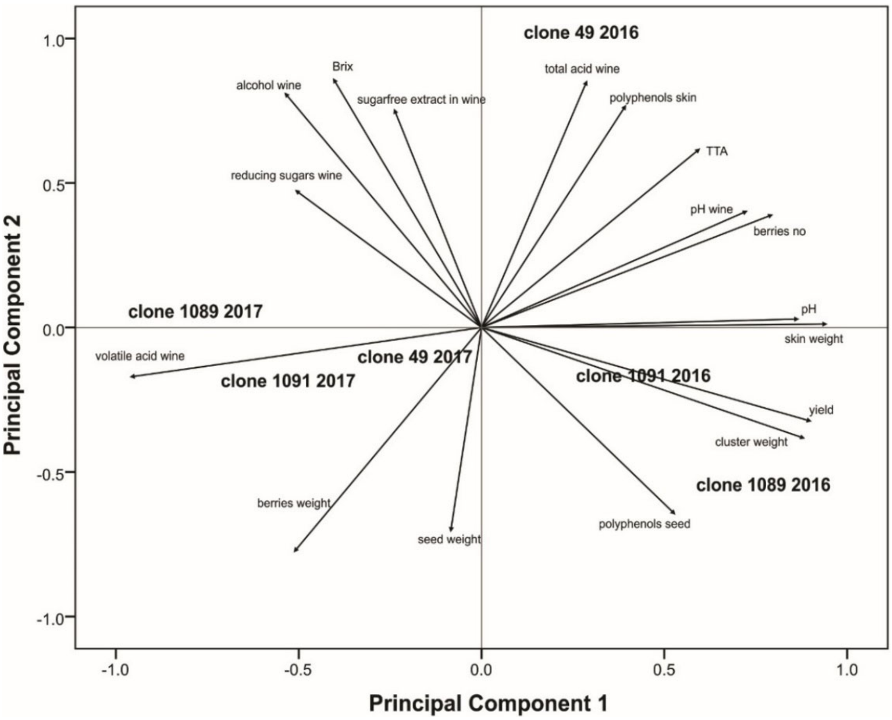

Figure 2. Principal components analysis of studied characteristics in clones and years.

affects the yield. Ćirković and Garić (2006) analyzed the yield of the Riesling Rhine variety with a load of 20 to 30 buds and in their study, yield ranged from 3.4 kg to 5.4 kg per grapevine. Variation in yield per grapevine during the research period was influenced by the year, which is in line with Kliewer and Dokoozlian (2005) who state that the yield potential of a variety in given climatic conditions is largely determined by total leaf area and percentage of leaf area exposed to the sunlight. According to Molitor and Keller (2016), climatic conditions had a significant impact on the yield of Müller-Thurgau and Riesling varieties, with a slightly more pronounced Riesling variety response, although the correlation between meteorological conditions and yield in the tested varieties was very similar. With few exceptions, the effect of temperature was mostly positive (i.e. higher temperatures were associated with higher yields), whereas the effect of precipitation was generally negative (i.e. higher precipitation was associated with lower yields).

4.2. Cluster and berry characteristics

The grape cluster weight of the tested clones was greatly influenced by the clone, which is in line with the statements of several authors stating that variations in the weight of grape berries in the Riesling variety ranged from 90.71 g to 150.00 g (Todić et al., 2000; Stroe and Ioana, 2015). Similar characteristics are shown by clones 198, Gm 239 (Pejović and Maraš, 1994) and clone B 21 (Jovanović-Cvetković et al., 2011). The test results of clone 49 (Baker, 2019) grown in Ontario (Canada), in terms of berry weight (146–165 g/100 berries) are in line with the results of our research, considering the large territorial distance. The results of a study by Ferrer et al. (2014) show that the weight of grape berries significantly depends on the variety and weight of individual components in the berry (especially flesh and seeds), as well as the production year and hydrological conditions during the growing season. Some authors have shown the relationship between berry weight and the content of components determining the must quality (Roby et al., 2004; Santesteban and Royo, 2006; Dai et al., 2011).

4.3. Grape quality

The grape quality in the study was significantly influenced by the clone, the year of research and their interaction. Obtained results are supported by statement that genotype (Liu et al., 2006) and climatic conditions (temperature, solar radiation, water availability) in certain phenological stages of cluster development have a significant influence on the sugar concentration and composition in mature grapes (Calò et al., 1996). This study results in terms of the total titratable acidity are relatively consistent with the results of a five-year study of Riesling Rhein variety, grown in the nearby region (Kutjevo, Croatia), where the total titratable acidity ranged from 5.5 g L^{-1} to 7.8 g L^{-1}, depending on the harvest year (Jakobović and Jakobović, 2005), as well as the results of study conducted in the warmer neighboring region (North Macedonia), where the value of this parameter was 6.45 g L^{-1} (Hristov, 2017). Pavloušek and Kumšta (2011) state that the average pH of Riesling grapes, in the three-year study, was 3.13, and the lowest measured value was 3.03. These results are consistent with the must pH values of the studied clones in 2016, which ranged from 3.01 to 3.18. On the other hand, in 2017, the pH of all clones was lower (from 2.81 to 2.89), which is in accordance with the results of a three-year study of the Riesling grapes acidity, reported by Duchêne et al., (2013).

4.4. Polyphenol content

Revilla et al. (1997) stated that the variation in the content of grape phenolic compounds is conditioned by various factors (variety, production year, location, degree of grape maturity). Significantly lower values of total phenolic content in the Riesling Rhine variety berries are stated by Brighenti et al., (2017) which confirms the fact that climatic conditions have influence on grape quality. A two-year study (Jakobović et al., 2015) showed a significant influence of the degree of maturity, locality, and year of production on the total concentration of phenols in grape and wine in Riesling Rhine. Research on the influence of microclimate on the phenolic and amino acid composition of Riesling grapes (Fridel et al., 2015) showed that the measure of defoliation in the cluster zone to increase cluster exposure to light, had a very significant positive effect on the content and concentration of phenolic compounds in berries. Phenolic compounds are one of the main parameters of wine quality and contribute to the organoleptic characteristics, particularly color, astringency, and body (Brighenti et al., 2017).

4.5. Wine characteristics

The alcohol content in the wine of all clones was in accordance with the sugar content and variations in the must (% Brix) in the both years of research. The alcohol content in the wines of clones 1089 and 1091 was lower compared to clone 049, but not in comparison to the results of alcohol content of Riesling Rhine wine, grown in the neighboring region (Croatia), which ranged from 11.90% v/v to 12.31% v/v (Herjavec, et al., 2001; Jakobović et al., 2009). In contrast to the alcohol content, the content of sugarless extract and the level of total acidity compared to the results of the above authors was lower in all studied clones. As a result of climate change, which is manifested primarily in the increase in air temperature (global warming) in many regions, the occurrence of higher levels of alcohol in wine has been observed. Certain research has shown that the potential alcohol level of Riesling Rhine, grown in Alsace (France), has increased by 2.5% (by volume) over the last 30 years, and this phenomenon is highly correlated with a much warmer period of grape ripening and earlier start of the vegetation (Jones, 2012). The influence of factors that determine the wine acidity (previously mentioned) is reflected in the wine total acidity, which is also affected by the vinification process. Fischer et al. (1999) state that the total acidity in Riesling Rhine wine largely depends on the microlocality and year of production, and that it ranges from 6.4 gL^{-1} to 9.4 gL^{-1}. Friedel et al. (2016) also state that the berry size in this variety can have an effect on the total acidity. According to Ribéreau-Gayon et al., (2004) it is difficult to predict the total acidity of wine based on the must acidity. The wine pH test results showed that the clone 1091 wine had the lowest value (2.59 in 2017), while the clone 049 wine had the highest value (2.84 in 2016). By comparing the values on an annual basis, the wines of all clones had a lower pH value in the second year of the research. The low pH value of wine, which is the result of the composition of acids in wine, has a beneficial, antimicrobial effect, because most of the bacterial growth is inhibited at low pH (Jackson, 2008). In addition, the positive effect of lower pH values is reflected in the prevention or delay of phenolic oxidation, which protects the white wines from browning (Volschenk et al., 2006). Although volatile acids are quantitatively negligible compared to other acids in wine, their quantity has always been an indicator of wine quality (Ribéeau-Gayon, 2004b). The obtained values of volatile acids indicate the normal course of fermentation and the possibility of maintaining the wine stability for a longer period of time. The berry size can also affect the volatile acidity (Friedel et al., 2016). Slightly higher values of the reducing sugars content (from 2.90 g/L to 5.37 g/L), as stated by Friedel et al. (2016), and these results are significantly influenced by berry size. Statistical analysis of the basic characteristics of wine of the studied clones indicates a statistically highly significant influence of the clone on most of the studied characteristics (except volatile acidity), while the highly significant influence of the year was shown in only certain characteristics (total wine acidity, volatile acidity and wine pH). Fischer et al. (1999c) stated that there is a strong need to study further the impact of meso- and macroclimate, soil type, viticultural and wine-making practices on wine composition, sensory properties and finally on consumer preferences. Without a better understanding of these important links, the classification of wine quality based on geographic origin alone seems to be inappropriate.

5. Conclusion

Based on the results of a two-year study of the production and oenological potential of Riesling clones, it can be said that clone 49 stood out with slightly better results in terms of production indicators, as well as more uniform yields compared to clones 1089 and 1091. Although the phenolic potential was quite variable during the study period in clones 49 and 1091, it was still the highest in clones 49. On average, the highest sugar content in the must and total titratable acidity was observed in clone 49, but other clones showed relatively good results in terms of the above parameters. The alcohol content in the wine and the total acidity were in line with the previously mentioned must quality indicators. Clone 49 had a higher sugarless extract content compared to other clones. Statistical analysis showed that both clone and year had a highly significant influence on most of the analyzed parameters, with the year significantly influencing some of the important parameters: grape berry weight, yield, sugar content, alcohol content and sugarless extract content in wine. The studied clones, grown in agroecological conditions of Ukrina's vineyards, have shown satisfactory results in terms of the grape and wine quality, which do not fall behind the Riesling variety compared to literature data.

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