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## **WINE QUALITY IN MONTENEGRO**

### **SUMMARY**

Intensive development of viticulture and winemaking sector is taking place in the last decade in Montenegro. Vineyard areas, the number of wineries and the number of wine types are increasing. In the structure of grape and wine production are still dominant red indigenous Montenegrin varieties, Vranac in composition with Kratošija. Among the producers of grapes and wine dominant position in Montenegro has the company "13. Jul-Plantaže" (94.5% of the total production i.e. quantity of 145.000 hl of all types of wine).

This paper presents results of Montenegrin wine quality analyses in the period from 2007.to 2014. Chemical analyzes were carried out in oenological laboratories of Biotechnical Faculty, as an integral part of the analysis for the market release of wines. Still, dry wines; red, white and rose were analysed.

Results of the analysis showed that wine Vranac from all producers has the highest uniformity in chemical composition. The average content of wine Vranac for the reference period is: 14.0 vol % of alcohol, total extract 28.0 g/l, total acidity 5.2 g/l and pH value of 3.50. This chemical composition is a typical composition for Montenegrin wine Vranac in Montenegro. Wine Kratošija from one producer and Cabernet Sauvignon from two producers were analysed.

White wines that were analysed were: Krstač, Chardonnay and Sauvignon. Among these wines the difference in the chemical composition of wines was recorded, especially in Chardonnay, and it is concluded that the characteristics of white wines are more dominated by production style of different producers than by the influence of variety. The average chemical composition for white wines analyzed is 13.6 vol% of alcohol, total extract 22.0 g/l, total acidity 5.9 g/l and pH value of 3.29. The characteristics of analyzed rose wines are distinguished by the style of production (alcohol content, extract and total acids) and all of them are characterized by elevated alcohol content.

**Keywords:** red wine, white wine, rose wine, dry wine, chemical composition of wine

### **INTRODUCTION**

Due to the favorable climatic and soil characteristics in Montenegro, vine growing and wine production have a very long tradition that extends to the period

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before the new era. This agricultural activity is associated to wine-growing region of Skadar basin and the Coastal region. Until World War II, the vineyard area in Montenegro was 1.145 ha (Pejović, 1988). The most significant increase in the vineyard area in Montenegro was in period from 1977 to 1982, with new plantations of 1.500 hectares within the project "Ćemovsko polje", property of the company "13.jul-Plantaže". In the last decade vineyard areas and the number of grape and wine producers also have increased. Law on wine published in 2007. and other government measures aimed to promote viticulture and wine production, particularly contributed to this trend. From 2007. to 2012. the vineyard areas were increased for 287 ha. During this period, 505 grape producers were registered. According to the latest MONSTAT records, total area under vines in Montenegro amounted for 2.700 ha at the end of 2014.

In the structure of vineyards in Montenegro, indigenous wine varieties Vranac and Kratošija dominate in the production of red wines, while in the production of white wine Chardonnay and Krstač are predominant. In "13.jul-Plantaže" company, 92% of plantations are wine varieties and 8% are table varieties of grape. The varieties of grapes intended for red wine production occupy 67% of the vineyards, while white varieties occupy 25%. Smaller producers mainly cultivate varieties of grapes used for wine production (94.1%), while table varieties hold only 5.9% of areas. The main grape varieties for the production of red wines are indigenous varieties Vranac and Kratošija, with 91.1% share, followed by Cabernet Sauvignon with 1.9% planted area. The most common variety used in the production of white wine is Chardonnay with 1.1%, followed by Krstač, Smederevka, Sauvignon, Žižak, etc. (MARD).

Wine production in Montenegro was officially registered in 55 wineries. According to EU classification, "13.jul-Plantaže" belongs to medium-size business, with a capacity of 17 million liters per year, and two wineries with a capacity of 0.3 to 10 million liters are small-size businesses.

Technological conditions of production in these companies fully meet internationally accepted standards. For other small producers (family businesses) technology of wine production ranges from the use of modern equipment to the traditional methods of production.

The total quantity of marketed wine in 2013 amounted to 142,559 hl. Company "13.jul-Plantaže" produced 94.5% and small wineries 7,872 hl, or 5.5% of total production. Red wines contributed with the biggest share (71.5%), followed by white wines (25.2%), and rosé wines (3.3%). From the aspect of quality categories, the most abundant are high quality wines with 54.4%, followed by quality wines with 40.4%, while table wines account for 5.1% (MARD).

Numerous of studies on quality of grapes and wine were conducted in Montenegro, and here it will be mentioned only a part of published studies. Ampelographic characteristics of the most important Montenegrin vine varieties in Montenegro described Ulićević (1966).

A detailed review of seven Montenegrin wines with geographical origin was done by Pejović (1987). Raičević et al. (2012) examined the impact of technological processes on the phenol content in wine Vranac. Savić (2013) described the characteristics of the Vranac wine produced from grapes coming from different localities. Pajović et al. (2013) studied the characteristics of nine renowned Vranac wine in a three-year period (2008-2010). Polyphenol profile of wines Vranac, Kratošija and Cabernet Sauvignon, based on the content of anthocyanins and hydroxycinnamic acid was defined by Pajović et al. (2014). Košmarel et al. (2014) examined the impact of the yield in some Montenegrin wines on antioxidative properties. Polyphenolic potential of Vranac, Cabernet Sauvignon and Kratošija was investigated by Pajović et al. (2014b) at 11 localities in Montenegro.

There is an evident trend of increasing vineyards and wine production, especially of small producers in Montenegro recently, which contributed to the increase in the number and types of wines. To our knowledge, studies on the characteristics of "new" wines in Montenegro haven't been done until now. Therefore, the objective of this work is to study and determine the quality of the wine in Montenegro, in recent years, based on their chemical composition. Long term analysis (2007-2014) has been performed, including the most common category of wines - dry wines: red (Vranac, Cabernet Sauvignon, Kratošija), white (Chardonnay, Sauvignon and Krstač) and rose. Based on a detailed analysis of chemical parameters, characteristics of the wine produced in Montenegro were defined.

## MATERIAL AND METHODS

This paper presents results of chemical analyzes of Montenegrin wines. Category of still, dry wines that are predominant in the wine production in Montenegro was analysed, and, classified by colour, all three categories: red, white and rose. Analyses were carried out in oenological laboratories of Biotechnical Faculty as an integral part of the controls before wine marketing. Wines were taken by the commission and are representative samples.

Chemical analyzes were performed in the laboratory for wine and decision on quality category was taken by the Commission formed by the Ministry of Agriculture and Rural Development. High-quality wines that can be found in the Montenegrin and wider market are presented.

Table 1 is an overview of the wines analyzed, name of producer-winery, the site from which grapes come from as well as the total annual production of wine. The producers listed release wines on market each year, allowing continuous and referent monitoring.

The following parameters of physicochemical composition of wine were tested: alcohol, extract, total acids, pH, volatile acids and residual sugar in wine. The analyses were performed in accordance with compendium of international methods of wine and must analyses (OIV, 2011).

Table 1: Data on wines analysed

<i>Wine</i>	<i>Period of analysis</i>	<i>Winery/ Producer</i>	<i>Locality</i>	<i>Prod. yearly</i>
Red wines				
<i>Vranac</i>				liters
„Crnogorski vranac“	2007-2013	13.jul-Plantaže	Ćemovsko polje, Podgorica	2.000.000
„Vranac Pro-Corde“	2007-2013	13.jul-Plantaže	Ćemovsko polje, Podgorica	1.000.000
“Crmički Vranac Sjekloča”	2007-2013	Sjekloča	Limljani, Crmnica, Bar	4.500
“Zenta Vranac”	2008-2012	Vučinić	Rogami, Podgorica	6.000
“Arhonto Vranac”	2009-2012	Krgović	Rogami, Podgorica	7.500
“Vranac”	2007-2013	Biotechnical Faculty	Lješkopolje, Podgorica	10.000
<i>Kratošija</i>				
“Zenta Kratošija”	2009-2014	Vučinić	Rogami, Podgorica	2.000
<i>Cabernet Sauvignon</i>				
“Crnogorski Cabernet”	2007-2013	13.jul-Plantaže	Ćemovsko polje, Podgorica	500.000
“Zenta Cabernet Sauvignon”	2007-2012	Vučinić	Rogami, Podgorica	3.000
White wines				
<i>Krstač</i>				
“Crnogorski Krstač”	2007-2014	13.jul-Plantaže	Ćemovsko polje, Podgorica	1.000.000
<i>Chardonnay</i>				
“Crnogorski Chardonnay”	2007-2014	13.jul-Plantaže	Ćemovsko polje, Podgorica	1.000.000
“Buk Chardonnay”	2010-2014	Rajković	Bukovik, Crmnica, Bar	2.000
“Arhonto Chardonnay”	2012-2014	Krgović	Rogami, Podgorica	7.500
<i>Sauvignon</i>				
“Crnogorski Sauvignon”	2007-2014	13.jul-Plantaže	Ćemovsko polje, Podgorica	150.000
Rose wines				
“Crnogorski Rose”	2009-2013	13.jul-Plantaže	Ćemovsko polje, Podgorica	150.000
“Zenta Rose”	2010-2014	Vučinić	Rogami, Podgorica	800
“Arhonto Rose”	2010-2014	Krgović	Rogami, Podgorica	8.000

## RESULTS AND DISCUSSION

### 1) Results of quality analysis of red wines

In Table 2. and 2a. results of chemical analysis for the red wines produced in Montenegro: Vranac, Cabernet Sauvignon and Kratošija are presented, and in table 2b average values of quality parameters for all types. In table 2b. mean values of quality parameters according to types and variety of red wines are shown. In table 2., analyzed red wines Vranac are presented.

### **Wine Vranac**

Red wine Vranac is dominant wine and it is produced from the autochthonous Montenegrin variety Vranac, usually in composition with Kratošija (in a significantly lower percentage). For most wine producers registered in Montenegro, prevailing position has wine Vranac in production range. However, here are presented only six wines Vranac, which have a reputation and that can be found in the market, "Crnogorski Vranac", "Vranac Pro Corde", "Crmnčki Vranac Sjekloća", "Zenta Vranac", "Arhonto Vranac" and "Vranac".

Wine „Crnogorski Vranac” is the product of the winery "13.jul-Plantaže". It is produced as high quality and premium wine. In this study (Table 2. are presented only the results of high quality red wines. Thanks to this wine, Vranac has become a recognizable Montenegrin brand, especially in the countries of the region, where it is still highly valued. It is produced in an amount of about two millions litars per year. Table 2. shows the chemical composition of this wine from 2007. to 2013. Density ranged from 0.9915 (2012) to 0.9938 (2008). The alcohol content varied from 12.9 vol % (2009) to 13.7 ol % (2012). Content of the extract ranged from 25.4 g/l (2007) to 29.2 g/l (2008). The content of the total acid is in the expected range for wine Vranac and varied from 4.7 g/l (2008) to 5.8 g/l (2012). pH value varied from 3.45 (2010) to 3.60 (2008). The volatile acid ranged from 0.60 g/l (2007) to 0.95 g/l (2008), and total sulphur content from 32.0 mg/l (2010) to 70.7 mg/l (2013). If we compare average results for the reference period (2007-2013) with a five-year average, reported by Pejović (1987), there is no significant variation in the values of the examined parameters. Pejović (1987) states that the alcohol content is 12.5 vol%, and our studies demonstrated 13.1 vol% averagely; total acid are uniform, averaging 5.1 g/l in both studies; content of the extract, excluding sugars in study of Pejović is 23.87 g/l and in our study is 26.6 g/l; the content of volatile acids is fairly steady and amounted to 0.75 g/l and 0.80 g/l. These data suggest a standard approach in the production technology of this wine for decades. Nevertheless, in our research are evident certain differences in the examined parameters per year, however not significant in the coefficient of variation.

Table 2. shows the data for another wine Vranac from producer "13.jul-Plantaže"- "Vranac Pro Corde". This wine is made by a special, protected technology that provides natural enrichment of wines with proanthocynidins, important antioxidative substances that enhance protection against coronary heart disease, and that is where the name originates from. Around one million liters of this wine are produced in a year. The paper presents the data for the period from 2007. to 2012. Table 2 shows that the density of the wine ranged from 0.9915 (2012) to 0.9942 (2008). The alcohol content varied from 13.5 vol% (2007) to 14.4vol % (2011). The total acid content ranged from 4.6 g/l (2009) to 5.6 g/l (2012), and pH value from 3.45 (2007) to 3.60 (2011). The volatile acid ranged from 0.55 g/l (2010) to 0.95 (2008) and the content of SO<sub>2</sub> from 28.01 mg/l (2008) to 121.42 mg/l (2012).

Table. 2: Chemical composition of red wines Vranac in Montenegro (per vintages)

Vinery	Vintage	Density	Alcohol vol %	Extract g/l	Total acidity g/l	pH	Volatile acidity g/l	Total SO <sub>2</sub> mg/l
“Crnogorski Vranac”								
Plantaže 13 Jul	2007	0.9930		25.3	5.2	3.50	0.60	64.70
	2008	0.9938	13.4	29.2	4.7	3.60	0.95	69.42
	2009	0.9926	12.9	27.0	4.8	3.59	0.69	39.60
	2010	0.9935	12.9	26.5	5.1	3.45	0.60	32.00
	2011	0.9935	13.3	25.8	4.9	3.55	0.80	47.00
	2012	0.9915	13.7	24.0	5.8	3.53	0.80	60.71
	2013	0.9935	13.4	28.4	5.3	3.58	0.80	70.78
	mean	0.9931	13.2	26.6	5.1	3.54	0.75	54.89
	CV (%)	0.08	2.5	6.70	7.3	1.3	16.9	28.0
“Vranac Pro Corde”								
Plantaže 13 Jul	2007	0.9934	13.5	27.0	4.8	3.55	0.80	39.45
	2008	0.9942	13.8	31.4	4.8	3.50	0.95	44.80
	2009	0.9920	13.4	24.2	4.6	3.60	0.55	28.01
	2010	0.9930	13.7	28.7	4.9	3.50	0.55	34.50
	2011	0.9925	14.3	27.9	4.6	3.47	0.85	55.10
	2012	0.9915	14.0	25.0	5.6	3.45	0.87	121.42
	mean	0.9928	13.8	27.4	4.9	3.51	0.76	53.88
	CV (%)	0.10	2.5	9.5	7.4	1.6	22.4	63.8
Sjekloća								
“Crminički Vranac Sjekloća”								
Sjekloća	2007	0.9915	14.8	27.4	5.5	3.73	0.60	55.04
	2008	0.9920	14.5	27.4	5.2	3.60	0.69	47.36
	2009	0.9930	13.7	28.1	5.4	3.55	0.80	122.88
	2010	0.9912	14.0	28.8	5.7	3.61	0.62	94.72
	2011	0.9920	14.4	27.4	5.4	3.71	0.85	115.00
	2012	0.9915	14.8	27.4	5.8	3.58	0.66	51.20
	2013	0.9925	14.4	28.1	4.7	3.79	0.65	84.03
	mean	0.9920	14.4	27.8	5.4	3.65	0.70	81.46
	CV (%)	0.06	2.8	2.0	7.0	2.5	13.5	38.2

## Vučinić

“Zenta Vranac”								
Vučinić	2008	0.9925	14.1	27.9	4.5	3.60	0.66	80.00
	2009	0.9920	13.2	26.0	4.8	3.54	0.60	102.40
	2010	0.9935	12.7	26.3	5.4	3.64	0.85	106.88
	2011	0.9920	14.5	27.6	5.3	3.42	0.70	83.20
	2012	0.9925	15.0	31.3	6.0	3.29	0.72	66.56
	mean	0.9925	14.8	30.0	5.2	3.42	0.70	87.97
	cv (%)	0.12	2.2	14.3	9.6	3.9	9.5	30.9

## Krgović

“Arhonto – Vranac”								
Krgović	2009	0.9915	14.3	25.8	4.9	3.55	0.65	87.68
	2010	0.9940	15.0	34.9	5.6	3.25	0.69	68.51
	2011	0.9930	15.0	32.3	5.7	3.38	0.67	69.16
	2012	0.9915	14.8	27.1	4.8	3.50	0.80	126.51
	mean	0.9925	14.8	30.0	5.2	3.42	0.70	87.97
	CV (%)	0.12	2.2	14.3	9.6	3.9	9.5	30.9

## “Vranac” Biotehnički fakultet

Biotehnički fakultet	2007	0.9935	14.0	30.2	5.0	3.40	0.80	61.00
	2008	0.9929	14.1	29.1	5.5	3.36	0.60	61.44
	2009	0.9927	14.0	28.9	5.7	3.30	0.68	59.70
	2010	0.9933	13.8	26.1	6.0	3.33	0.70	55.78
	2011	0.9925	14.3	28.4	5.0	3.33	0.79	72.36
	2012	0.9925	14.0	27.9	4.9	3.55	0.62	57.97
	2013	0.9925	14.0	27.9	5.9	3.30	0.65	71.50
	mean	0.9928	14.0	28.4	5.4	3.37	0.69	62.82
	CV (%)	0.04	1.1	4.5	8.5	2.6	11.3	10.4

The six-year average of the parameters for wine "Vranac Pro Corde", compared to the average for wine "Crnogorski Vranac" shows a higher alcohol content of 0.7 vol %, higher extract content for 0.8 g/l and a balanced amount of acid content, pH value of 3.50 and volatile acids 0.75 g/l.

This paper also analyzes the characteristics of the wine Vranac from first registered private wine producers in Montenegro - Winery "Sjekloća". This

producer has built a considerable reputation for the quality of his products, primarily wine "Crnjički Vranac Sjekloča". This wine is produced from the grape variety Vranac, which is grown in locality Limljani (Crmnica, Bar). It is produced in quantities of around litters. The results of chemical analysis for this wine (period from 2007. to 2013.) are shown in table 2. Density varied from 0.9912 (2010) to 0.9930 (2009). The alcohol content ranged from 13.7 vol% (2009) to 14.8 vol% (2007/2012), and the content of the extract from 27.4 g/l to 28.8 g/l. The total acid content ranged from 4.7 g/l (2013) to 5.8 g/l (2012), and we registered high pH value of 3.55 (2009) to 3.79 (2013). The volatile acid ranged from 0.60 to 0.85 g/l, and total sulphur content from 47.36 to 122.88 mg/l.

Wine "Arhonto Vranac" is produced in Rogami locality, in the winery, "Krgović" with modern equipment for production and raw material of exceptional quality, which results in superior quality of this wine. Annual production of this wine is around 7.500 litters. Characteristics of this wine for the period from 2009. to 2012. are given in Table 2. Density ranged from 0.9915 (2009/12) to 0.9940 (2010). The content of alcohol is high and ranged from 14.3 vol% (2009) to 15.0 vol% (2010/11), and the total extract content from 25.8 g/l to 34.9 g/l. Total acid content ranged from 4.8 g/l to 5.7 g/l (2011), and pH value from 3.25 (2010) to 3.55 (2009). Volatile acids were quite uniform 0.65 in 2009 g/l to 0.80 g/l in 2012, and total sulphur content measured was from 68.51 mg/l (2010) to 126.51 mg/l (2012).

Wine "Vranac" from winery of Biotechnical Faculty (former Agricultural Institute) is another wine with a long tradition in Montenegro. Due to scientific research orientation of this institution, this wine was available on market only in bulk under the local name "Institute's wine". In 2007. wine was officially released on the market under the name "Vranac". It is made from grape variety Vranac on locality Lješkopolje, near Podgorica. It is known for a remarkable quality. The chemical composition of this wine is given in table 2, for the period from 2007. to 2013. Density was fairly consistent from 0.9925 in three years (2011/13) to 0.9935 in 2007. The content of alcohol was constant, ranging from 13.8 vol% (2010) to 14.3 vol% (2011). Content of the extract was 26.1 g/l (2010) and 30.2 g/l (2007).

The total acid content varied from 4.9 g/l to 6.0 g/l, and pH value ranged from 3.30 (2009) to 3.40 (2007). Volatile acids were equal, 0.60 g/l and 0.80 g/l and the sulphur content was from 55.78 mg/l to 72.36 mg/l.

Table 2. also presents two recent Vranac wine producers from the localities Rogami in vicinity of Podgorica "Arhonto Vranac" and "Zenta Vranac". Wine "Zenta Vranac" is produced since 2007. in the winery "Vučinić" that has modern equipment for the production and with outstanding quality of grapes produces superior quality wine every year. It is produced since 2008. in an amount of about 6.000 l. Table 2 presents the chemical characteristics of this wine Vranac for the period from 2008 to 2012. Density ranged from 0.9920 (2011) to 0.9935 (2010) and an alcohol content from 12.7 vol% (2010) to 15.0 vol% (2012). In accordance with these values, was the content of extracts ranging from 26.0 g/l to



31.3 g/l (2012). The total acid content also varied from 4.5 g/l to 6.0 g/l (2012), as well as the pH value; 3.29 (2012) and 3.64 (2010). Volatile acids were uniform, from 0.60 g/l (2009) to 0.85 g/l (2010), and the total sulphur ranged from 66.50 mg/l (2012) to 106.88 mg/l (2010).

Table 2a. presents the chemical characteristics of wine Kratošija (one type) and Cabernet Sauvignon wines (two types).

Table. 2a: Chemical composition of red wines Kratošija and Cabernet Sauvignon in Montenegro (per vintages)

Vinery	Vintage	Density	Alcohol vol %	Extract g/l	Total acidity g/l	pH	Volatile acidity g/l	Total SO <sub>2</sub> mg/l
	KRATOŠIJA WINE							
	“Zenta Kratošija”							
Vučinić	2009	0.9925	15.3	31.3	4.8	3.55	0.65	72.96
	2010	0.9925	13.5	27.0	6.0	3.49	0.65	76.95
	2011	0.9940	15.7	36.5	5.6	3.63	0.80	71.68
	2012	0.9915	15.0	29.2	5.3	3.42	0.69	72.96
	2013	0.9965	15.5	43.1	8.9	3.38	0.75	108.61
	2014	0.9935	12.3	25.8	6.8	3.29	0.57	112.28
	mean	0.9934	14.6	32.2	6.2	3.46	0.69	85.91
	CV	0.18	9.3	20.4	23.8	3.5	11.9	22.9
	CABERNET SAUVIGNON WINES							
	“Crnogorski Cabernet”							
Plantaže 13 Jul	2007	0.9935	13.5	28.7	5.0	3.50	0.75	64.00
	2008	0.9940	13.4	29.6	5.0	3.55	0.95	64.00
	2009	0.9915	13.5	27.5	4.7	3.65	0.72	40.15
	2010	0.9930	13.5	26.9	4.6	3.60	0.60	60.49
	2011	0.9932	13.4	27.4	5.4	3.45	0.60	52.48
	2012	0.9915	13.6	23.7	5.9	3.47	0.66	107.05
	2013	0.9925	13.9	27.4	5.4	3.48	0.75	78.88
	mean	0.9927	13.5	27.3	5.1	3.53	0.72	66.72
	CV	0.10	1.33	6.8	8.7	2.10	16.8	32.0

	"Zenta Cabernet Sauvignon"							
Vučinić	2007	0.9930	13.9	28.4	4.7	3.65	0.88	76.00
	2008	0.9925	14.6	29.2	5.0	3.55	0.75	147.00
	2009	0.9919	14.6	28.9	5.5	3.54	0.80	147.00
	2010	0.9920	13.7	25.3	5.4	3.48	0.85	116.48
	2011	0.9915	15.0	27.9	5.4	3.53	0.72	92.80
	2012	0.9925	13.4	25.8	5.8	3.40	0.71	62.72
	mean	0.9922	14.2	27.6	5.3	3.53	0.79	107.00
	CV	0.05	4.4	6.0	7.9	2.3	8.9	33.5

### Wine Kratošija

Although Kratošija is considered as indigenous Montenegrin variety in Montenegro there is only one wine Kratošija. This is the "Zenta Kratošija" produced by Winery also have increased "Vučinić". Table 2a. presents characteristics of this wine for the period from 2009. to 2014. Specific weight ranged from 0.9915 (2012) to 0.9965 (2013). The alcohol content was high and ranged from 12.3 vol% (2014) to 15.7 vol%. The content of the extract varied significantly from 25.8 g/l (2014) to 36.5 g/l (2011). Due to contents of acid ranging from 4.8 g/l (2009) to 8.9 g/l (2013), the pH value varied from 3.29 (2014) to 3.63 (2011). The volatile acid ranged from 0.57 g/l (2014) to 0.80 g/l (2011), and total sulphur content from 71.68 mg/liter to 112.28 mg/l (2014).

### Wine Cabernet Sauvignon

Cabernet Sauvignon is the famous French wine dominating worldwide in quantity and quality. In previous years in Montenegro production of this wine has increased due to outstanding performance of wines and grapes. The largest area under vines of this variety, and thus the largest production has company "13.jul-Plantaže". "Crnogorski Cabernet" is produced in the amount of half a million liters per year. The results of chemical analysis for the period from 2007. to 2013. are shown in Table 2. Specific weight ranged from 0.9915 (2009) to 0.9940 (2008). The alcohol content was uniform, from 13.4 vol% (2008) to 13.9 vol% (2013), and the content of the extract varied from 23.7 g/l to 29.6 g/l. The content of total acids ranged from 4.6 g/l (2010) to 5.9 g/l (2012) and pH value ranged from 3.47 (2012) to 3.65 (2009). Volatile acid ranged from 0.60 g/l (2010) to 0.95 (2008), while the overall sulphur content ranged from 40.15 mg/l to 107.1 mg/l.

In Table 2a. are presented characteristics of another wine, Cabernet Sauvignon, called "Zenta Cabernet Sauvignon", which is produced in locality Rogami, in winery "Vučinić". This wine has the highest quality, and is produced

in the amount of about 3.000 liters. Table 3. shows the characteristics of this wine for the period from 2007. to 2012. Specific weight of this wine ranged from 0.9915 (2011) to 0.9930 (2007). The alcohol content varied from 13.4 vol% (2012) to 15.0 vol% (2011), and extract contents from 25.8 g/l (2012) to 29.2 g/l (2008). The total acid content ranged from 4.7 g/l (2007) to 5.8 g/l (2012), and pH from 3.40 (2012) to 3.65 (2007). Volatile acids were equal; 0.71 g/l (2012) and 0.88 g/l (2007), and the total sulphur ranged from 62.72 mg/l (2012) to 147.00 mg/l (2008/9).

Table. 2b: Chemical composition of red wines in Montenegro (average values)

<i>Wine</i>	<i>Vintage (from-to)</i>	<i>Density</i>	<i>Alcohol vol %</i>	<i>Extract g/l</i>	<i>Total acidity g/l</i>	<i>pH</i>	<i>Volatile acidity g/l</i>	<i>Total SO<sub>2</sub> mg/l</i>
<i>Vranac wines</i>								
"Vranac Pro Corde"	2007-2012	0.9928	13.8	27.4	4.9	3.51	0.76	53.88
"Crnogorski Vranac"	2007-2013	0.9931	13.2	26.6	5.1	3.54	0.75	54.89
"Crmički Vranac Sjekloća"	2007-2013	0.9920	14.4	27.8	5.4	3.65	0.70	81.46
"Zenta Vranac"	2008-2012	0.9925	13.9	27.8	5.2	3.50	0.71	87.81
"Arhonto Vranac"	2009-2012	0.9925	14.8	30.0	5.2	3.42	0.70	87.97
"Vranac"	2007-2013	0.9928	14.0	28.4	5.4	3.37	0.69	62.82
mean		0.9926	14.0	28.0	5.2	3.50	0.72	68.20
CV (%)		0.04	4.32	4.55	4.08	3.11	4.50	22.92
<i>Kratišija wine</i>								
"Zenta Kratošija"	2009-2014	0.9934	14.6	32.2	6.2	3.46	0.69	85.91
<i>Cabernet Sauvignon wines</i>								
"Crnogorski Cabernet"	2007-2013	0.9927	13.6	27.3	5.1	3.54	0.74	69.1
"Zenta Cabernet Sauvignon"	2007-2012	0.9922	14.2	27.6	5.3	3.53	0.79	107.0
mean		0.9925	13.87	27.46	5.22	3.53	0.75	86.86
CV (%)		0.04	3.39	0.74	2.27	0.03	6.70	32.79

Wine Vranac from six producers was analyzed and showed fairly uniform characteristics. Density is very uniform and ranges from 0.9920 to 0.9930. The content of alcohol and extract varied from 13.2 vol% and 26.6 g/l in wines "Crnogorski Vranac" to 14.8 vol% and 30.0 g/l for wine "Arhonto Vranac". Total acidity varies from 4.9 g/l in wines "Vranac Pro Corde" to 5.4 g/l in wine

"Vranac" and pH value from 3.37 to 3.65 in wine "*Crmnčki Vranac Sjekloča*". Volatile acids are uniform, ranging from 0.69 g/l to 0.76 g/l, and the total sulphur content was from 53.88 mg/l to 87.97 mg/l. The average contents of wine Vranac in our study, shown in Table 2b. is as follows: the alcohol content 14.0 vol%, extract contents 28.0 g/l, total acidity 5.2 g/l, pH 3.50, volatile acidity 0.70 g/l and total sulphur 68.20 mg/l. It can be concluded that this chemical composition is typical composition of the Montenegrin wine Vranac in Montenegro. The alcohol content in our study (13.2-14.8 vol%) is slightly higher than the results in the survey stated by Pajović *et al.* (2013) - 12.8 to 13.7 vol%, who also studied wine Vranac for 2008-2011 period, whereas alcohol content was from 13.03 to 13.33 vol%. for the period 2008-2011 stated by Raičević *et al.* (2014), and significantly higher than the values (11.15 vol% to 12.40 vol%) cited by Savić (2014) and Pejović (1987) - 12.5vol%. The content of the extract in our survey, from 26.6 to 30.0 g/l, was also higher than in the above mentioned studies. Pajović *et al* (2014) reported values of 25.4 to 27.2 g/l, Savić (2014) 23.85 g/l, and Pejović (1988) 23.82 g/l. Unlike the previous two parameters, total acid content in our studies (4.9 to 5.4 g/l) is consistent with the values of 4.8 to 5.5 g/l measured by Pajović *et al.* (2014), 5.34 g/l which states Savić (2014) and 5.1 g/l stated by Pejović (1988).

The table 2b.also shows wine Kratošija characteristics, as an average, for only one producer "*Zenta Kratošija*". The average content of wine Kratošija is as follows: the alcohol content of 14.6 vol%, extracts content 32.2 g/l, total acidity 6.2 g/l, pH value of 3.46, volatile acidity 0.69 g/l and the total sulphur 85.91 mg/l. Values of alcohol in this study are consistent with the values of 14.2 vol% for 1999, which shows Pajović *et al.* (2002), but higher than the value (11.50 to 13.00 vol%), for the wine produced from this variety reported by Pejović *et al.* (1988).

Wine Cabernet Sauvignon in Table 2b. is shown as a multi-year average for the two producers and the results are quite uniform. The values of specific weight and extract of these two wines amounts for 0.9922 and 27.6 g/l in wine "*Zenta Cabernet Sauvignon*" and 0.9927-27.3 g/l in wine "*Crnogorski Cabernet*". The alcohol content ranges from 13.6 to 14.2 vol% and is uniform in the content of total acids (5.1 and 5.3 g/l), as well as the pH value (3.54 and 3.53) and the content of volatile acid (0.74 and 0.79). The average content of wine Cabernet Sauvignon in our study, presented in Table 2b is as follows: the alcohol content 13.90 vol%, the content of the extract 27.5 g/l, total acidity 5.2 g/l, pH 3.53, volatile acidity 0.75 g/l and the total sulphur 86.86 mg/l. Values of alcohol content are consistent with the values specified by Avramov (1991) - 12.5 to 14.0 vol% and 14.3% reported by Pajović *et al.* (2009), but significantly higher than the value of 10.9 vol% cited by Pejović *et al.* (1996).

## 2) Results of white wines quality studies

Table 3 presents the results of chemical analysis for white wines produced in Montenegro; Krstač, Chardonnay and Sauvignon.

Tabela 3: Chemical composition of white wines in Montenegro (per vintages)

	<i>Vintage</i>	<i>Density</i>	<i>Alcohol vol %</i>	<i>Extract g/l</i>	<i>Total acidity g/l</i>	<i>pH</i>	<i>Volatile acidity g/l</i>	<i>Total SO<sub>2</sub> mg/l</i>
Vinery	KRSTAČ WINE							
	“Crnogorski Krstač”							
Plantaže 13 Jul	2007	0.9913	13.7	23.5	4.8	3.50	0.35	112.6
	2008	0.9911	12.9	20.6	5.3	3.40	0.65	97.3
	2009	0.9911	12.9	20.8	5.4	3.45	0.35	92.2
	2010	0.9896	13.1	19.0	5.9	3.15	0.42	85.8
	2011	0.9916	12.9	21.3	6.5	3.15	0.60	121.6
	2012	0.9915	13.2	22.7	6.0	3.19	0.44	198.5
	2013	0.9915	13.1	22.4	5.6	3.29	0.50	107.9
	2014	0.9900	13.4	19.3	6.3	3.14	0.40	112.1
	mean	0.9910	13.2	21.2	5.7	3.28	0.50	116.0
	CV (%)	0.09	2.2	10.5	9.8	4.5	24.0	30.5
CHARDONNAY WINES								
Plantaže 13 Jul	“Crnogorski Chardonnay”							
	2007	0.9902	13.0	22.7	5.4	3.40	0.30	121.6
	2008	0.9905	13.4	20.6	5.2	3.45	0.60	82.0
	2009	0.9905	13.3	20.3	6.1	3.37	0.55	88.3
	2010	0.9900	13.7	20.1	6.8	3.19	0.55	119.0
	2011	0.9915	13.9	25.0	7.1	3.19	0.55	134.4
	2012	0.9915	13.7	24.0	6.9	3.14	0.41	102.5
	2013	0.9915	13.9	25.0	6.0	3.27	0.60	147.4
	2014	0.9900	13.1	18.5	6.7	3.14	0.45	100.5
	mean	0.9907	13.5	22.0	6.3	3.27	0.50	112.0
	CV (%)	0.07	2.6	11.3	11.4	3.8	21.1	20.2
“Buk Chardonnay”								
Buk	2010	0.9883	14.0	21.4	5.8	3.31	0.73	128.0
	2011	0.9900	14.5	22.4	6.7	3.14	0.75	106.2
	2012	0.9900	15.0	24.0	6.7	3.18	0.57	112.6
	2013	0.9900	13.9	20.9	6.6	3.18	0.57	105.8
	2014	0.9910	12.9	20.3	7.2	3.13	0.45	109.7
	mean	0.9899	14.1	21.8	6.6	3.19	0.61	112.46
	CV (%)	0.10	5.6	6.7	7.7	2.3	20.4	8.10

	“Arhonto Chardonnay”							
Krgović	2012	0.9915	15.0	28.1	6.0	3.37	0.51	149.5
	2013	0.9910	14.9	26.3	5.3	3.44	0.80	128.0
	2014	0.9900	13.7	20.1	5.3	3.47	0.55	177.5
	mean	0.9908	14.5	24.8	5.5	3.43	0.62	151.67
	CV (%)	0.08	5.0	16.9	7.0	1.5	25.4	16.4
	SAUVIGNON WHITE WINE							
	“Crnogorski Sauvignon”							
Plantaže 13 Jul	2007	0.9880	13.1	19.6	4.8	3.50	0.50	90.9
	2008	0.9903	13.3	20.3	4.9	3.55	0.60	80.5
	2009	0.9906	13.5	20.3	6.4	3.20	0.40	81.9
	2010	0.9900	12.9	19.9	5.8	3.15	0.51	75.1
	2011	0.9915	13.8	23.7	6.9	3.19	0.80	73.0
	2012	0.9915	13.7	24.0	6.9	3.15	0.45	131.9
	2013	0.9915	14.1	25.3	6.0	3.30	0.60	133.2
	2014	0.9910	13.5	22.4	6.0	3.20	0.45	124.0
	mean	0.9906	13.5	21.9	6.0	3.28	0.54	98.81
	CV (%)	0.12	2.9	10.0	13.4	4.8	23.6	26.6

### Wine Krstač

White wine "Crnogorski Krstač" is produced from the indigenous Montenegrin variety Krstač with protected origin (according to the Lisbon Convention). There is only one producer of this wine in Montenegro - "13.jul-Plantaže". Wine is produced as high quality and superior wine. In this study (Table 3) are presented results of superior wine Krstač for the period from 2007. to 2014. The specific weight of this wine varies in years, from 0.9896 (2010) to 0.9916 (2011). The alcohol content ranges from 12.9 vol% (2008) to 13.7 vol% (2007). Extract content ranges, in accordance with the values of the previous two parameters from 19.0 g/l (2010) to 23.5 g/l (2007). Total acid content varies in different harvests; 4.8 g/l in 2007 and 6.5 g/l in 2012 with average value of 5.7 g/l. pH values ranged from 3.14 (2014) to 3.50 (2007). Volatile acid content amounted from 0.35 (2007) to 0.60 g/l (2011), and the total SO<sub>2</sub> from 85.6 (2010) to 198.5 mg/l (2012).

The average alcohol content in wine Krstač in our study (13.2 vol %) significantly differs from the content reported by Pejović (1987) as the average of the five-year tests of the same producer was 11.2 vol%, but it is consistent with recent studies of these wines presented by Košmarel *et al*.

(2013) - 12.8 ol% in the same locality. The total acid content for the eight-year average in our study is 5.8 g/l, which is more than what was presented by Pejović (1987) - 5.0 g/l and lower than the value of the researcher Košmarel et al. (2013) - 6.1 g/l. The average content of total extract in our analysis is 21.2 g/l and it is in alignment with results reported by Pejović (1987) - 19.4 g/l, and Košmarel et al. (2013) - 19.6 g/l showing the same value of extracts without sugar. The differences in alcohol content in previous studies for the five-year period by Pejović (1987), and our eight-year period are explained by different trends in wine production. In eighties (20th century) wines produced had alcohol content up to 12 vol% and in nineties trend of production of wines with higher alcohol content of 13 to 15 vol% was initiated.

### **Wine Chardonnay**

White wine Chardonnay is a famous French wine, which has been successfully produced from the same name variety all over the world and in Montenegro as well (Pejović and Mijović, 2004). In recent years, vineyards with this variety are significantly increasing, and number of producers of this wine. In this study are presented results of the analysis of three reputable producers of this wine (Table 3). Wine "Crnogorski Chardonnay" is produced in largest amounts, about one million liters per year, and has the longest tradition in production since 2003. From 2007. barrique wine is produced. Results of the analysis of high quality wine "Crnogorski Chardonnay", produced with classical methodology by "13.jul-Plantaže", for the period from 2007 to 2014 are shown in Table. 3. Density of wine ranges from 0.9900 to 0.9915 in tested years. The alcohol content varied from 13.0 vol% (2007) to 13.9 vol% (2013). Extract is content of wine- all non-volatile substances (Daničić, 1988), varies in years from 18.5 g/l 2014 to 25 g/l (2013). The total acid content of the wine "Crnogorski Chardonnay" ranged from 5.2 (2008) to 6.7 g/l (2014), and pH value from 3.14 (2014) to 3.45 (2008). The content of volatile acids varied and ranged from 0.30 to 0.60 g/l. Total SO<sub>2</sub> content ranged from 82 mg/l to 147 mg/l. Given the long tradition and experience of this wine producer ("13.jul-Plantaže") it is suggestible that the differences in the values of the parameters analyzed, with minor values of coefficient of variation, resulted from variable weather conditions in harvest years.

White wine "Chardonnay Buk" from "Buk" winery is produced in Montenegro from grapes grown at the highest altitude (about 700 m), at the location of Bukovik in Crmnica, resulting in specific sensory properties. The total production of this wine is around 2.000 liters per year, with the tendency of producers to increase quantities. Its

characteristics are analyzed since 2010, when production of wine begins. The results are shown in Table 3. Wine "Buk Chardonnay" wines density ranges from 0.9883 (2010) to 0.9910 (2014). The alcohol content varies greatly, from 12.9 vol% (2014) to 15.0 vol% (2012), as well as the content of the extracts from 20.3 g/l (2014) to 24.0 g/l (2012). Due to the geographical location of the vineyard, this wine has a higher total acid content; 5.8 g/l (2010) to 7.2 g/l (2014). pH value was 3.13 in 2014 and 31.3 measured in 2010. Based on the differences in analyzed parameters, we can state a clear impact of harvest. It is known that the 2014. harvest was one of the worst in the last decade and it reflected on the quality of wine produced. Volatile compounds in the wine "Buk Chardonnay" ranged from 0.45 g/l to 0.75 g/l, and the total SO<sub>2</sub> content were quite uniform, from 105.8 mg/l (2013) to 128.0 mg/l (2010).

This paper presents the characteristics of the wine "Arhonto Chardonnay" for a three-year period from 2012 to 2014.

Despite the short period in the market, this wine has good reputation. The analysis results are shown in Table 3. Density of wine ranges from 0.9900 (2014) to 0.9915 (2012). The alcohol content is very high - 13.7 vol% (2014) to 15.0 vol% (2012), and the extract content - 20.1 g/l (2014) to 28.1 (2012). The total acid content ranged from 5.3 g/l to 6.0 g/l (2014), and pH value from 3.37 (2012) to 3.47 (2014). The volatile acidity ranged from 0.5 g/l (2012) and 0.8 g/l (2013), and the SO<sub>2</sub> from 128.0 mg/l (2013) to 177 mg/l (2014). The results of the study for this wine also suggest the effect of unfavourable harvest in 2014 when all parameters measured were lower.

Data presented indicate that alcohol content in the analyzed wine Chardonnay varies from 13.5 vol% to 14.5 vol%, and the acid content from 5.5 g/l to 6.6 g/l.

The results of our study are consistent with results obtained by Avramov (1991); alcohol content from 12.0 vol% to 14.0 vol% and total acid content from 6.0 g/l to 7.5 g/l.

### **Wine Sauvignon**

Wine Sauvignon is another famous French white wine that is widely spread in Italy, Slovenia, Croatia, Romania, Moldova, Serbia and Montenegro, with good productivity results (Bozinović, 2005). Despite its high reputation in the world, only one producer in Montenegro - "13.jul-Plantaže" is producing this wine with name "Crnogorski Sauvignon". Table 3 shows the chemical parameters for an eight-year period (2007-2014). Specific weight of this wine ranges from 0.9880 (2007) to 0.9915 in several years period. The alcohol content ranged from 13.1 vol% (2007) to 14.1 vol% (2013), and the extracts content from 19.6 g/l (2007) to 25.3



g/l (2013). The total acid content varied significantly in the observed period: during 2007. and 2008. amounted for 4.8 g/l and 4.9 g/l, in 2010, 5.8 g/l, and in 2012- 6.9 g/l. The pH ranged from 3.15 (2012) to 3.55 (2008). Volatile acid varied from 0.45 g/l (2014) to 0.80 g/l (2011), and the total SO<sub>2</sub> content from 80.5 mg/l (2008) to 133.2 mg/l (2013).

Table 3a: Chemical composition of for white wines in Montenegro (average values)

Wine	Vintage (from-to)	Density	Alcohol vol %	Extract g/l	Total acidity g/l	pH	Volatile acidity g/l	Total SO <sub>2</sub> mg/l
Krstač wine								
“Crnogorski Krstač”	2007-2014	0.9910	13.2	21.2	5.7	3.28	0.50	116.0
Chardonnay wines								
“Crnogorski Chardonnay”	2007-2014	0.9907	13.5	22.0	6.3	3.27	0.50	111.9
“Buk Chardonnay”	2010-2014	0.9899	14.1	21.8	6.6	3.19	0.61	112.5
“Chardonnay Arhonto”	2012-2014	0.9908	14.5	24.8	5.5	3.43	0.62	151.7
Mean		0.9905	14.0	22.9	6.1	3.30	0.58	125.4
CV (%)		0.05	3.59	7.34	9.24	3.71	11.55	18.17
Sauvignon white wine								
“Crnogorski Sauvignon”	2007-2014	0.9906	13.5	21.9	6.0	3.28	0.54	98.81
White wine (average)								
Mean (all white wines)		0.9907	13.6	22.0	5.9	3.29	0.54	113.4
CV (%)		0.03	2.99	3.87	3.51	0.35	7.41	11.89

In wine “Crnogorski Sauvignon” the highest variation is measured in the content of total acidity, and therefore in pH value, which is not reflected in the presented coefficient of variation. Values of alcohol content and acidity in eight-year average (13.5 vol% and 6.0 g/l) in our research are consistent with the values of the parameters (12-14 vol% and 5-6.5 g/l) of wine Sauvignon stated by Avramov (1991). Table 3a presents the average values of all analyzed white wines.

Looking at averages (Table 3a.), for all three types of wine: Krstač, Chardonnay and Sauvignon, we see that the specific weight is uniform and ranges from 0.9905 in Chardonnay wines to 0.9910 in Krstač. The content of alcohol and extract varies from 13.2 vol% and 21.2 g/l respectively for wine Krstač to 14.0 vol% and 22.9 g/l for wines Chardonnay. The total acid content



	2010	0.9918	11.4	22.5	6.3	3.10	0.55	160.00
	2011	0.9920	14.8	28.7	6.8	3.05	0.85	92.16
	2012	0.9915	13.3	22.9	5.8	3.28	0.54	94.72
	2013	0.9930	13.0	26.3	6.4	3.21	0.65	94.38
	2014	0.9940	12.5	27.1	7.1	3.25	0.55	97.26
	mean	0.9925	12.99	25.5	6.5	3.18	0.63	107.70
	CV - %	0.10	9.7	10.6	7.5	3.1	21.0	27.2
Krgović	"Arhonto Rose"							
	2010	0.9899	12.9	22.3	5.4	3.35	0.50	112.6
	2011	0.9915	14.1	25.0	6.0	3.17	0.60	122.9
	2012	0.9910	15.0	26.6	5.7	3.21	0.54	118.2
	2013	0.9910	14.5	25.0	5.1	3.29	0.45	115.6
	2014	0.9900	13.6	19.8	6.0	3.33	0.69	169.7
	mean	0.9907	14.0	23.7	5.6	3.27	0.56	127.8
	CV - %	0.07	5.8	11.3	7.1	2.4	16.7	18.6

Characteristics of three rose wines produced in the period from 2009. to 2014. are presented: "Crnogorski Rose", "Zenta Rose" and "Arhonto Rose". The longest tradition in the production of this type of wine and the largest production capacity (about 150.000 litters) has wine "Crnogorski Rose" produced by "13.jul-Plantaže". Chemical characteristics of this wine are presented for the period from 2009. to 2014. Specific weight of the wine ranges from 0.9900 (2010) to 0.9928 (2009). Alcohol content varies slightly, from 12.5 vol% (2014) to 13.0 vol% (2009/10). Extract content ranged from 21.1 g/l (2012) to 25.3 g/l (2009). Total acid content varied significantly from 5.3 g/l (2009) to 6.8 g/l (2014), as well as pH value from 3.00 (2011) to 3.30 (2009). The volatile acid ranged from 0.40 g/l (2014) to 0.70 g/l (2009), and the total SO<sub>2</sub> content was from 69.12 mg/l (2009) to 153.40 mg/l (2012). The average content of the quality parameters of wine in our six-year testing was as follows: alcohol content 13.2 vol%, extract content 21.2 g/l, total acidity 5.7 g/l. In the five-year study of Pejović (1987) describing the same wine was stated: alcohol content 11.50 vol% extract content 24.0 g/l and total acid content 5.3 g/l. From these results, the conclusion is that in the last period changed the style of this wine production. Wine "Crnogorski Rose" has significantly higher alcohol content and acidity, and a lower content of extract nowadays. In table 4. another rose wine is presented, "Zenta Rose", produced at the site Rogami, winery "Vučinić". An overview of the characteristics of this wine, for the period from 2010. to 2014., is shown. Specific weight of wine ranged from 0.9915 (2012) to 0.9940 (2014). The alcohol content varied from 11.4 vol% (2010) to 13.3 vol% (2012), and extract content from 22.5 g/l (2010) to 28.7 g/l (2011). The total acid content ranged from 5.8 g/l (2012) to 6.8 g/l

(2011), and pH from 3.05 (2011) to 3.28 (2012). The volatile acids content measured was from 0.54 g/l (2012) to 0.85 g/l (2011), and the total sulphur ranged from 92.16 mg/l (2012) to 160.0 mg/l (2008/9).

Wine "Arhonto Rose" is another rose wine produced in Rogami, in the winery "Krgović". Annual production of this wine is around 8.000 liters. The characteristics of this wine for the period from 2010 to 2014 are given in Table 4. Density ranged from 0.9899 (2010) to 0.9915 (2011). The content of alcohol was high and varied considerably, from 12.9 vol% (2010) to 15.0 vol% (2012), as well as the total extract content ranging from 19.8.8 g/l to 26.6 g/l.

Table. 4a: Chemical composition of rose wines in Montenegro (average values)

Wine	Vintage (from- to)	Density	Alcohol vol %	Extract g/l	Total acidity g/l	pH	Volatile acidity g/l	Total SO <sub>2</sub> mg/l
<i>Rose wines</i>								
"Crnogorski Rose"	2009- 2013	0.9916	12.8	22.3	6.0	3.14	0.57	106.64
"Zenta Rose"	2010- 2014	0.9925	13.0	25.5	6.5	3.18	0.63	107.7
"Arhonto Rose"	2010- 2014	0.9907	14.0	23.7	5.6	3.27	0.56	127.8
mean		0.9916	13.3	23.8	6.0	3.20	0.59	114.05
CV (%)		0.09	4.9	6.8	7.5	2.1	6.5	10.5

Table 4a shows the average content by type of wine and the average for rose wines produced in Montenegro.

In the table 4a. are presented average characteristics of analysed rose wines for the observed five/six-year period. Specific weight varied from 0.9907 in "Arhonto Rose" to 0.9925 in "Zenta Rose". Alcohol content measured was 12.8 vol % in "Crnogorski Rose" to 14.0 vol% in "Arhonto Rose". The values of total extract also varied from 22.3 g/l in "Crnogorski Rose" to 25.5 g/l in "Zenta Rose". Acid content also significantly varies among these wines, ranging from 5.6 g/l in "Arhonto Rose" to 6.5 g/l in "Zenta Rose", and therefore the pH value as well, from 3.14 in "Crnogorski Rose" to 3.27 in "Arhonto Rose". Content of volatile acids of 0.57 g/l to 0.63 g/l, and the total sulphur content from 106.6 mg/l to 127.8 g/l are almost uniform for all producers. Average chemical composition of rose wines for the reference period is: 13.3 vol% of alcohol, total extract 23.8 g/l, total acidity 6.0 g/l and pH value 3.20. Yet, from results of analysis of each individual producers it is apparent that three rose wines analysed differ in the most important parameters that affect its properties: the content of alcohol (which determines the strength of the wine), extract (which gives fullness) and total acids (which give freshness). Thus it is concluded that the characteristics of the analyzed rose wines vary in style of production and all of them are characterized by elevated alcohol content.

## CONCLUSION

The structure of plantations in Montenegro is dominated by indigenous wine varieties Vranac and Kratošija for the production of red wines, and Chardonnay and Krstač for the production of white wine. Vineyard areas planted have significantly increased in last decade and the number of grape and wine producers, as well as the number of types of wines produced in the viticulture and winemaking sector in Montenegro. This paper presents results of analysis of quality of still, dry wines (red, white and rose) produced in the period from 2007 to 2014.

Red wines analysed were Vranac („*Crnogorski Vranac*”, “*Vranac Pro Corde*”, “*Crmnčki Vranac Sjekloča*”, “*Zenta Vranac*”, “*Arhonto Vranac*” and “*Vranac*”) Kratošija (“*Zenta Kratošija*”) and Cabernet Sauvignon (“*Zenta Cabernet Sauvignon*” and “*Crnogorski Cabernet*”). Among the white wines, wines Krstač (“*Crnogorski Krstač*”), Chardonnay (“*Crnogorski Chardonnay*”, “*Buk Chardonnay*” and “*Chardonnay Arhonto*”) and Sauvignon (“*Crnogorski Sauvignon*”) were analysed. Three types of rose wines were analysed: “*Crnogorski Rose*”, “*Zenta Rose*” and “*Arhonto Rose*”.

The average content for wine Vranac for the reference period was: the alcohol content of 14.0 vol%, extract content 28.0 g/l, total acidity 5.2 g/l and pH value 3.50. It can be concluded that the chemical composition is a typical composition of the Montenegrin wine Vranac in Montenegro. Average chemical composition of the wine Kratošija is as follows: the alcohol content 14.6 vol%, the content of extracts 32.2 g/l, total acidity 6.2 g/l and pH value 3.46. The average content of wine Cabernet Sauvignon in our study was: alcohol 13.90 vol%, total extract 27.5 g/l, total acidity 5.2 g/l and pH value 3.53.

The average content of white wine Krstač for the reference period was: alcohol content 13.2 vol%, extracts 21.2 g/l, total acidity 5.7 g/l and pH value of 3.28. The average content of wine Chardonnay is as follows: 14.0 vol% of alcohol, total extract 22.9 g/l, total acidity 6.1 g/l, pH value of 3.30. Average chemical composition of wine Sauvignon is: alcohol 13.5 vol%, total extract 21.9 g/l, total acidity 6.0 g/l and pH value of 3.28. The listed characteristics of white wines are more dominated by production style of wineries, compared to the variety of grape.

The characteristics analyzed for rose wines vary in production style (alcohol content, extract and total acids) and all of them are characterized by elevated alcohol content. Average chemical composition of wine rose for the reference period was: 13.3 vol%, total extract 23.8 g/l, total acidity 6.0 g/l and pH value of 3.20.

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