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CHEMICAL COMPOSITION AND SENSORY PROPERTIES OF WINE VRANAC IN THE SKADAR LAKE BASIN (MONTENEGRO)

SUMMARY

The sector of wine growing and winemaking in Montenegro has over the past few years been developing intensively. Area under vineyards and production of red wines in both regions of the Montenegrin basin of the Lake of Skadar and Montenegrin coastal region has been significantly increasing. The Vranac grape variety and wine dominates the plantations and production, which is why understanding the quality of this wine in Montenegro, is of particular importance. This paper presents the results of our research of the Vranac wine produced in various localities with a view to obtaining the data valid for typisation of properties of this national brand.

Over the period of three years, from 2008 to 2010, nine Vranac wines from eight localities in the Montenegrin basin of the Skadar Lake that belong to the Podgorički and Crmnički sub-regions were studied. Meteorological conditions were observed, chemical composition of wine was analysed and sensory properties of wine using the OIV method were appraised. The wines were analysed while young.

There were no differences in mean monthly temperatures in the years of the research, while precipitation in the grape ripening period in 2010 was higher in both sub-regions under research. The values of the Huglin index were lower in the Crmnički sub-region (2900-3100) than in Podgorički (3400-3600). The chemical analysis established that all wines tested had a high alcohol content (from 12.8 to 13.7 vol%) and extract (25.4-27.2 g/l) and a low level of total acids (4.8 to 5.5 g/l) on average by years. Sensory appraisal of wine shows that the highest scoring wines was vintage 2009, and that the wines produced in localities with longer tradition have continuously been achieving superior quality, while in all others the wine quality varied by years observed.

Key words: Vranac wine, chemical composition, sensory quality, locality

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INTRODUCTION

Owing to its geographical position and favourable climate, grape growing and winemaking have always been developed in Montenegro and have traditionally been based on indigenous wines, Vranac and Kratošija. Kratošija variety had dominated until the emergence of phylloxera; however, its role was then assumed by Vranac, which featured a lower heterogeneity and better skin coloration (Ulićević, 1966, Pejović, 1988).

The world trend of favouring red wine varieties which was observed after a study entitled "French Paradox" (Renaud & De Logeril, 1992) dealing with the health benefits of polyphenolic compounds in red wines, as well as long tradition of producing Vranac wine, have brought about the expansion of areas planted with red wine varieties in the more recent stage of the development of the vine and wine sector in Montenegro (over the last 10 years). The grape variety Vranac is still dominating the vineyards. Accounting for as much as 80% of total red wine production, Vranac dominates among the wines, whereas Kratošija is rarely produced and Cabernet Sauvignon is on the rise (Pajović, 2009). Vranac wine is characterized by high content of alcohol and extract and a low content of total acids, which is typical of wines from southern regions. Until recently, most of production of the Vranac wine took place at the locality Ćemovsko Field and to a lesser extent in the locality Lješkopolje. Over the past years, the number of wine produces in other localities has been significantly growing, particularly in the Podgorički sub-region. In addition to the increase in number of wine producer of the Vranac variety in Montenegro, a lot of effort was invested in modernization of production technology, which resulted in a production of a better quality wine. All that contributed to an increase in the palette of the Vranac wine in Montenegro.

The objective of this paper is to analyse and determine the properties and quality of the Vranac wine from eight localities, based on chemical and sensory analyses. Based on these properties, the typisation of properties of the Vranac produced in Montenegrin viticultural region will be possible.

MATERIAL AND METHODS

In this experiment, the Vranac wines produced in the following localities of the Podgorički sub-region were used: Lješkopolje (1), Ćemovsko Field (2 and 3) Rogami (5), Kuči (6), Kokoti (7), Beri (9) and Crmnički sub-region: Limljani (4) and Godinje (8). Samples were taken from wines of six renowned private producers and three wines produced in industrial facilities.

Analyses of three vintages were made: 2008, 2009 and 2010. The following meteorological factors were observed: mean monthly and mean vegetation temperatures, mean monthly and mean vegetation precipitation. Values of Huglin Index were determined, as well. Wine analyses were performed in the laboratory of the Biotechnical Faculty. The wines were analysed while young, in January of the following year. The following parameters of physico-chemical 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). The appraisal of sensory properties was done by a commission (five members) by OIV point scoring method. The following elements were appraised: aspect, bouquet, flavour, and overall evaluation. The maximum score that a wine can get with such appraisal is 100. The OIV point scoring method comprises the following wine categories: table wine without geographical indication score 60 to 64.99; table wines with controlled geographical indication score 65 to 74.99; quality wines with controlled geographical origin score 75 to 84.99; superior wine scoring more than 85 (OIV, 2009).

RESULTS AND DISCUSSION

Meteorological factors

Since weather has a particular effect on the degree of grape ripening and hence the chemical composition of must and wine, we are presenting the key meteorological data for some of climatic elements in the Podgorički and Crmnički sub-regions in the years in which the research was conducted as well as for the five-year period.

Table 1: Some meteorological factors for examined sub-regions

Vintage	Podgorički sub-region			Crmnički sub-region		
	Sr. v. t. (C°)	Sr v. k. p. (mm)	HI	Sr. v. t. (C°)	Sr v. k. p. (mm)	HI
2008	22.1	552	3662	21.0	469	3116
2009	22.3	654	3571	21.2	643	3153
2010	21.7	796	3450	20.8	819	2975

Sr. v. t. – mean vegetation temperature

Sr v. k. p.- mean vegetation precipitation

HI – Huglin Index

During the ripening period, the air temperature plays a determinant role for grape maturation, including the aroma and the coloration, having an important effect on the characteristics of the wines (Jackson and Lombard, 1993). Mean vegetation temperature in the two sub-regions under research was quite high. It ranged from 21.7 C° in 2010 to 22.3 C° in 2009 in the Podgorički sub-region. In the period under research, somewhat lower values were recorded in the Crmnički sub-region, 20.8 to 21.2 C°. Vegetation sum of precipitation in Podgorički sub-region ranged from 552 mm in the course of 2008 to 796 mm in the course of 2010. The same trend was recorded in Crmnički sub-region: the lowest level in the course of 2008 – 469 mm and the highest in the course of 2010, 819 mm. Huglin (1978) developed the Heliothermal Index of Huglin, which is applicable at

a world-wide range, established over a period which is closest to the average cycle of the grapevine. It takes into account the length of the day for the highest latitudes, uses the daily temperatures and displays a good relation to the potential of sugar content of the grape. The Huglin Index values in Podgorički sub-region ranged from 3450 in 2010 to 3662 in 2008. In Crmnički sub-region these values were lower and ranged from 2975 in 2010 to 3153 in 2009.

Chemical composition of wine

The quality of wine as a product of alcoholic fermentation of grape juice depends primarily on the composition and quality of grapes, then on the grape processing method, wine storage and care. The wine quality is characterized by its chemical composition and sensory properties. Table 2 below gives an overview of results of the key parameters of chemical composition of wine by years under research.

All wines had a density ranging from 0.991 to 0.995, while average density by years was balanced and ranged from 0.9920-0.9930. Alcohol content in all producers, on average, was the highest in 2008, 13.7 vol %, somewhat lower in 2010, 13.1 vol %, and the lowest in 2009, 12.8 vol%. In producers from localities 1, 2, 3, 4 and 7, alcohol content variation by vintages is much lesser than in the remaining four. The alcohol content in the Vranac wines was higher than stated by Pejović (1987), 12.5 vol%, when he made the typisation of the Vranac wine properties. This can be explained with the trend of making wine with higher alcohol content in Montenegro. The extract content of the Vranac wine ranged from 20.3 to 33.1 g/l, and on average by year it ranged from 25.4 and 27.3 g/l. On average, by years, the residual sugar content ranged from 2.0 g/l in the course of 2008 to 2.4 g/l in 2010. Based on these values, all the wines were placed under the category of dry wines.

The values of total acid content were balanced on average, in the course of 2008 and 2009 4.8 g/l, while in 2010 it was 5.5 g/l. The trend of high total acid content in 2010 among all producers is interesting. It can be explained by higher precipitation in the vegetation period.

pH values correlate with total acid values by years. The volatile acids content ranges from 0.4 to 0.8 g/l on average, while by years it ranged from 0.5 to 0.6 g/l.

Values of analysed parameters of chemical composition of wine do not deviate yearly, on average, for all samples. Smaller deviations are present in wines of producers 1, 2, 3, 4 and 7 for all parameters analysed by years, compared to other producers.

Table 1: Chemical properties of the Vranac wine in the course of 2008, 2009 and 2010

Sample number	1.	2.	3.	4.	5.	6.	7.	8.	9.	Average	CV (%)	
Specific weight	2008	0.993	0.993	0.993	0.994	0.993	0.993	0.993	0.992	0.991	0.993	<i>0.1</i>
	2009	0.994	0.992	0.993	0.993	0.994	0.992	0.995	0.995	0.992	0.993	<i>0.1</i>
	2010	0.994	0.992	0.992	0.991	0.993	0.993	0.994	0.993	0.992	0.992	<i>0.1</i>
Alcohol vol %	2008	14.2	13.5	13.8	13.9	14.1	14.1	13.2	12.5	13.6	13.7	<i>4.0</i>
	2009	13.9	13.1	13.5	13.5	12.3	12.0	12.9	11.4	12.5	12.8	<i>6.3</i>
	2010	13.9	13.5	13.7	14.8	12.5	12.0	12.7	13.3	11.5	13.1	<i>7.8</i>
Extract g/l	2008	29.4	27.4	28.1	31.3	29.2	29.2	27.9	20.6	22.4	27.3	<i>12.8</i>
	2009	31.0	23.7	24.2	27.4	23.2	20.3	30.7	26.3	21.9	25.4	<i>14.7</i>
	2010	33.1	27.9	26.9	27.9	26.9	22.7	29.8	28.2	21.7	27.2	<i>12.6</i>
Sugar g/l	2008	3.3	1.6	1.9	1.9	1.4	2.0	2.1	2.2	2.1	2.0	<i>26.7</i>
	2009	3.8	2.2	2.2	2.1	2.0	2.1	2.6	1.6	1.8	2.2	<i>28.0</i>
	2010	3.8	2.5	2.3	1.7	2.5	2.1	2.6	2.2	1.8	2.4	<i>25.7</i>
Total acidity g/l	2008	4.6	4.1	4.4	5.2	4.5	5.4	4.9	5.2	5.4	4.8	<i>9.8</i>
	2009	5.6	4.5	4.7	5.2	4.8	4.7	5.6	3.9	4.7	4.8	<i>10.8</i>
	2010	6.5	5.3	5.5	5.6	5.9	6.2	5.5	5.5	3.7	5.5	<i>14.4</i>
pH	2008	3.65	3.70	3.60	3.55	3.60	3.45	3.62	3.52	3.45	3.57	<i>2.4</i>
	2009	3.41	3.67	3.59	3.75	3.53	3.53	3.55	3.68	3.48	3.58	<i>3.0</i>
	2010	3.32	3.50	3.48	3.52	3.49	3.46	3.55	3.51	3.86	3.52	<i>4.1</i>
Volatile acids g/l	2008	0.8	0.6	0.6	0.6	0.4	0.8	0.8	0.4	0.8	0.6	<i>25.9</i>
	2009	0.6	0.4	0.4	0.5	0.7	0.4	0.4	0.4	0.4	0.5	<i>24.0</i>
	2010	0.7	0.6	0.5	0.4	0.5	0.7	0.5	0.4	0.5	0.5	<i>21.0</i>

The data on values of parameters of chemical composition of the Vranac wine analysed are in line with the results of previous analyses of this wine from the locality in Lješkopolje (Pajović et al. 2002 and Pajović et al. 2011).

Sensory analysis of wines under research

Implementation of chemical, physico-chemical and instrumental methods of chemical analyses can produce an accurate and objective analysis of wine composition; however, sensory analysis gives the final opinion on the wine quality. Sensory analysis appraises, above all, the harmony of quantities of specific ingredients which, to a large extent, influences the drinkability and harmony of wine. Sensory and chemical analyses complement each other and contribute to a more comprehensive and fuller wine quality analysis (Thorngate, 1997). The overview of results of sensory appraisal, by OIV method, of the Vranac wine under research is presented in the Table 3 below.

Aspect is appraised by observing the wine brilliance and colour. For all wines tested, on average, difference among vintages when it comes to aspect not been noted. The scores ranged from 16.1 to 16.3. However, in all three years, the Vranac wine of producers 2 and 3 got the highest score as well as wines of producers 4 and 7 in vintages 2009 and 2010.

Bouquet is appraised by the assessment of correctness, intensity and quality. On average, by years, the best appraised bouquet was of wines vintage 2009, with 25.4, and the lowest vintage 2008, with 24.5. Best appraised bouquet of wines was in producers 2 and 3 for all three vintages – scored about 26.

Flavour is appraised through assessment of the following parameters: correctness, intensity, persistence and quality. On average, by years, the best appraised wine flavour is vintage 2009 with score 36.2, and the least scoring was vintage 2008 with 30.1. In all three vintages under research the Vranac wine flavour of producers 2 and 3 had the highest score, and for producers 4 and 7 in vintages 2009 and 2010.

Harmony or overall evaluation was assessed best in wines of vintage 2009, with 7.1. Harmony in wines of all three vintages was the best appraised in producers 2 and 3, while for vintages 2009 and 2010 in producers 4, 5 and 7.

The total score, summing the scores of all previous parameters defines the quality category of the wine and it is presented in the Table 3 below. Most of superior wines (six) and one quality wine, with highest average score (84.4) was vintage 2009. In vintage 2008, there are only two superior wines, one quality and all others were assessed as table wines with average score of just 79.2. By wine quality, vintage 2010 falls in between the other two. In 2010 there were four superior, two quality and three table wines. Producers 2 and 3 achieved superior wine quality in all three years under research, while producers 4 and 7 achieved that in vintages 2009 and 2010. Producers 1 and 5, too had superior wine, vintage 2009.

Table 3: Sensory evaluation of wines tested vintages 2008, 2009 and 2010

	Aspect (max 18)			Bouquet (max 30)			Flavour (max 44)			Harmony Overall evaluation (max 8)			Total (max 100)		
	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010
1	16.9	16.0	16.2	25.0	25.9	24.5	30.1	36.2	34.0	6.5	7.0	7.0	78.5	85.1*	81.7 ^o
2	17.0	16.4	17.0	26.0	26.5	26.0	36.0	36.9	37.0	7.0	7.4	7.2	86.2*	87.2*	87.2*
3	17.0	16.7	17.2	26.0	26.4	26.5	35.0	37.0	37.5	7.0	7.5	7.5	85.1*	87.6*	88.7*
4	16.1	17.0	17.0	25.2	25.4	25.5	30.2	36.0	36.5	6.1	7.2	7.5	77.6	85.4*	86.5*
5	15.5	17.0	16.0	24.2	26.6	25.0	32.3	37.0	34.5	6.2	7.4	7.2	78.2	88.0*	82.7 ^o
6	15.4	15.8	15.6	23.0	25.6	24.5	30.3	31.8	32.0	6.3	6.6	6.7	75.0	79.8	78.8
7	15.1	17.1	17.2	25.0	25.8	26.0	34.0	35.9	36.0	7.0	7.0	7.2	82.1 ^o	85.8*	86.4*
8	16.2	15.0	15.0	23.3	21.6	22.0	29.6	34.4	30.0	6.0	6.6	6.3	75.1	77.6	73.3
9	16.1	16.0	15.8	23.2	25.0	24.0	30.3	35.2	33.0	5.4	7.0	6.2	75.0	83.2 ^o	79.0
Mean	16.1	16.3	16.3	24.5	25.4	24.9	30.1	36.2	34.5	6.4	7.1	7.0	79.2	84.4	82.7
CV(%)	4.1	4.2	4.9	4.7	6.0	5.4	7.6	4.7	7.3	8.5	4.6	6.9	5.4	4.3	6.1

* - Superior wines with controlled geographical origin

^o - Quality wines with controlled geographical origin

CONCLUSION

In the period of research of the Vranac wine produced from grapes harvested in 2008, 2009 and 2010, the climatic conditions in the viticulture region of the Skadar Lake basin were quite balanced and favourable for achieving good ripening of grapes.

Chemical analyses of nine samples of the Vranac wine from six locations of the

Podgorički and two locations of the Crmnički sub-region showed high (mean) alcohol content, ranging from 12.8 to 13.7 vol% and high (mean) extract content ranging from 25.4 to 27.3 g/l. By residual sugar content all wines fell into the category of dry wines (2.2 do 2.4 g/l). Total acid contents on average was 4.8 g/l, while in 2010 it was 5.5 g/l, which is probably resulting from precipitation increase by 20-30% compared to the previous year. Volatile acids content was low on average and balanced (0.5 and 0.6), indicating the health safety of wines tested. The presented results of the wines analysed are for the most part in line with the results of earlier studies on this wine from the abovementioned viticulture regions.

Based on the assessment of sensory properties of wines tested, it is shown that the vintage had a significant effect on wine quality. Thus, in 2009, six wines fell into the category of superior wines, in 2010 those were four, and in 2008 only two. The analyses showed also that in all three years of research, the superior and quality wines produced come from winemakers with a long tradition and modern technological equipment.

Since the Vranac grape vine variety does not vary significantly throughout the region when it comes to quality, it means that in the future production (of superior) wines in Montenegro, particular attention needs to be paid to technical work and supply of modern wine making equipment.

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REFERENCES

- Compendium of international methods of wine and must analyses -Volume 1, (2011) OIV International organisation for viticulture and enology, Paris
- Huglin, P., (1978): Nouveau mode d'évaluation des possibilites héliothermiques d'un milieu viticole. In: Proceedings of the Symposium International sur l'ecologie de la Vigne. Ministère de l'Agriculture et de l'Industrie Alimentaire, Contança, pp. 89–98.
- Jackson, D.I., Lombard, P.B., (1993): Environmental and management practices affecting grape composition and wine quality: a review. *Am. J. Enol. Vitic.* 4, 409–430.

- OIV Standard for International Wine and Spirituous Beverages of Vitivincultural Origin Competitions (2009) OIV International organisation for viticulture and enology, Paris
- Pajović, R., Mijović, S., Prenkić R., Popović, T. (2002): Uticaj klimatskih faktora na sazrevanje grožđa i kvalitet vina sorti vranac i kratošija. VI savetovanje industrije alkoholnih i bezalkoholnih pića i sirćeta sa međunarodnim učešćem, Vrnjačka Banja. Zbornik radova: 127-133
- Pajović, R., Popović, T., Krstić, M., Vukosavljević, V.,(2011): Influence of temperature fermentation to the dynamic of fermentation and quality red wine vranac. *Agroznanje*, vol.12., No.4, pp. 427-436. Banja Luka, Republic of Srpska.
- Pajović, R., Popović, T., Boškov, K., Beleski, K. (2009): Technological characteristics of introducing varieties Merlot and Cabernet Sauvignon in the Podgorica wine growing region (Montenegro) and Skopje wine growing region (Macedonia): *Agroznanje*, vol.10., No. 1: 89-96.
- Pejović, L. (1988): Ampelografska proučavanja varijeteta Kratošije. *Jugoslovensko vinogradarstvo i vinarstvo*, br. 3-4: 21-33.
- Pejović, Lj., (1987): Karakteristike vina Crne Gore. *Jugoslovensko vinogradarstvo i vinarstvo*, br. 7-8: 56-61.
- Renaud, S. & De Legeril, M., (1992): Wine, alcohol, platelets, and the French Paradox for coronary heart disease. *Lancet* 339: 1523-1526.
- Thorngate, John H. (1997): The Physiology of Human Sensory response to wine. A review. *Am.J.Enol.Vitic.*, 48: 271-278.
- Ulićević, M. (1966): Prilog proučavanju osobina najvažnijih sorata vinove loze gajenih u SR Crnoj Gori. *Arhiv za poljoprivredne nauke*, 23:1-100.

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**HEMIJSKI SASTAV I SENZORNE
KARAKTERISTIKE VINA VRANAC U
BASENU SKADARSKOG JEZERA (CRNA GORA)**

SAŽETAK

Vinogradarsko-vinarski sektor Crne Gore posljednjih godina doživljava nagli rast. Značajno se povećavaju površine pod vinogradima i proizvodnja crvenih vina na prostorima u okviru oba regiona Crnogorskog basena Skadarskog jezera i Crnogorsko primorskog regiona. Sorta grožđa i vino Vranac dominira u zasadima i u strukturi proizvodnje zbog čega poznavanje kvaliteta ovog vina u Cnoj Gori ima poseban značaj. U ovom radu prikazani su rezultati naših proučavanja vina vranac proizvedenog na raznim lokalitetima kako bi se dobili validni podaci za tipizaciju karakteristika ovog nacionalnog brenda.

Tokom trogodišnjeg perioda, od 2008 do 2010 god., ispitivano je 9 vina Vranac sa osam lokaliteta u okviru Crnogorskog basena Skadarskog jezera koji pripadaju Podgoričkom i Crmničkom subregionu. Praćeni su meteorološki uslovi, analiziran je hemijski sastav vina i vršena je ocjena senzornih svojstava vina po metodi OIV-a. Vina su analizirana kao mlada.

Srednje mjesečne temperature se tokom ispitivanih godina nijesu razlikovale, dok je količina padavina u periodu sazrijevanja grožđa u 2010 godini bila veća u oba ispitivana subregiona. Vrednosti Huglinovog indexa su bile niže u Crmničkom subregionu (2900-3100) nego u Podgoričkom (3400-3600). Hemijskom analizom je utvrđeno je da su sva ispitivana vina imala visok sadržaj alkohola (od 12.8 do 13.7 vol%) i ekstrakta (25.4-27.2 g/l) i nizak sadržaj ukupnih kisjelina (4.8 do 5.5 g/l), posmatrano kao prosek po godinama. Senzorna ocjena vina je pokazala da su najbolje ocenjena vina u berbi 2009 godini, kao i da vina koje se proizvode na lokalitetima sa dužom tradicijom kontinuirano postižu vrhunski kvalitet, dok kod ostalih- kvalitet vina varira po ispitivanim godinama.

Ključne riječi: vino Vranac, hemijski sastav, senzorni kvalitet, lokalitet