QUALITY AND ANTIOXIDANT PROPERTIES OF PINOT NOIR GRAPEVINE VARIETY UNDER AGROECOLOGICAL CONDITIONS OF VRŠAC IN SERBIA

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ABSTRACT

This research was focused on the antioxidant properties of grape variety Pinot Noir in the period from 2009-2011 in Vojvodina (location Vršac - 45^{O} 8' 40,80" N; 21° 24' 7,97" E, 199 m a. s. l.). Pinot Noir variety was grown on Berlandieri x Riparia Kober 5BB rootstock, at a distance of 3 x 0.8 m. Mechanical properties of bunch and berry, quality and chemical properties of grapes were analyzed. The contents of monomeric and polymeric anthocyanins in grape berry skin were 11.68 and 94.67 mg of malvidin-3-glucoside/g. Correlative relationship between phenolic content and antioxidant activity of berry skin was r = 0.754, n = 18, p <0.0005. Quality and antioxidant activity of Pinot Noir grape variety was determined to be high under the agroecological conditions of Vršac in Serbia.

INTRODUCTION

Production of high quality grape and wine depends on the relationship of different factors such as: locality, climate, soil, grapevine variety and applied agrotechnical and ampelotechnical measures. Contribution of each of these factors is not equal considering their complex relationship (Vaudour, 2002; Jones et al., 2004). Grape yield and quality are affected during the production process by agroecological conditions of locality. Grape chemical composition is especially affected by the applied viticulture practices and ecological conditions of the locality where grape variety is grown (Jackson and Lombard, 1993). When vegetation and reproductive development of grapevine are adapted to ecological conditions, mature grape has adequate ratio and content of sugar, acids, aromatic and phenolic compounds, or other quality parameters desired for the production of high quality wine (Jones and Davis, 2000; Jones, 2006; Van Leeuwen et al., 2008).

Evaluation of grape quality is based on different parameters. Sugar content and acid are very important indicators of grape quality and produced wine. Apart from sugar content, total acids and their ratios, quality of grapes grown for wine production is considerably influenced by the content of antioxidant compounds. Phenolic compounds as antioxidants can be found in different parts of grape bunch and berries and at different concentrations (Prieur et al., 1994). Besides optimal content of sugar and acids, high content of some phenolic compounds in berries is especially desired when grapes are grown for the production of red wines (Mattivi et al., 2002).

This paper presents the investigation of quality parameters of Pinot Noir grapevine variety which was grown under the agroecological conditions of Vojvodina, at the locality of Vršac.

MATERIAL AND METHODS

The aim of this study was to analyze quality and antioxidant properties of Pinot Noir grapevine variety under agroecological conditions of Vršac in Serbia. All tests were performed in the production vineyard 'Vršački vinogradi - Gudurica'. The vineyards are located in the region of Banat, sub-region of South Banat and wine growing region of

Vršac, at 45^{o} 8´ 40.80´´ of northern latitude and 21^{o} 24´ 7.97´´ of eastern longitude. In the study period from 2009-2011 Pinot Noir variety was grown on *Berlandieri* x *Riparia* Kober 5BB rootstock with modified asymmetric cordon training system. The following were investigated: elements of mechanical composition of a bunch and berry, quality of grapes and phenolic content in the berry skin. The tested elements of mechanical composition of a bunch and berry were: length, width, bunch mass, stem mass, berry mass and seed mass. The quality of grapes was determined on the basis of sugar content and total acids in the must. Sugar content was examined by refractometer (Pocket Atago Pal 1). Total acids were determined using a broader titration with n/4 NaOH. Total phenol content was determined by spectrophotometric method (AOAC, 1984) and total anthocyanin content by pH differential method (Shahidi and Marian, 2003). Antioxidant activity was determined with DPPH radicals. The measured data were statistically analyzed using the software package SPSS version 17.0. Correlation between phenolic content and antioxidant activity was determined by Pearsons´s test (Tabachnick and Fidell, 2007).

RESULTS AND DISCUSSION

Mean monthly temperatures in Vršac during the investigation years are given in Figure 1, and mean monthly sums of precipitation are given in Figure 2.

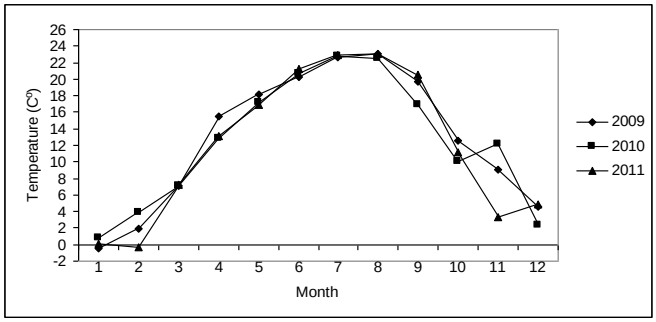


Figure 1. Mean monthly temperatures (2009 - 2011)

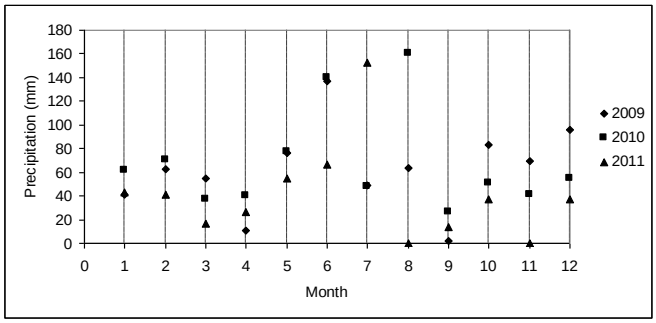


Figure 2. Mean monthly sums of precipitation (2009 - 2011)

Meteorological parameters (temperature and precipitation) varied with respect to the year of investigation. The hottest month in 2009 was August, when mean monthly temperature was 23^{o}C, and in 2010 the hottest month was July with mean temperature of 22.8^{o}C. In 2011, the hottest month was August again when mean temperature was 23.1^{o}C. In the years of investigation, the coldest month was January (Figure 1). As for precipitation, in 2009, 2010 and 2011 there was 854.6 mm, 779.0 mm and 472.6 mm of precipitation, respectively (Figure 2).

Table 1 shows bunch and berry properties which were determined during the investigation years. Some differences were determined with respect to several indicators of mechanical composition and those differences varied depending on the properties that

were investigated for particular year. Table 2 shows that the ecological conditions in the investigated years did not affect bunch mass.

Table 1

Descriptive Statistics of bunch and berry properties

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Bunch length	30	7	13	9.64	1.461	2.134
Bunch width	30	3	7	4.93	1.007	1.013
Bunch mass	30	75	130	103.80	14.787	218.648
Stem mass	30	3.25	5.12	4.28	0.52	0.27
Single berry mass	30	0.39	1.47	1.05	0.21	0.45
Single seed mass	30	0.14	0.65	0.04	0.01	0.00

Table 2

Results of ANOVA test of statistical analysis of bunch mechanical properties at Vršac locality (2009 - 2011)

Property	Variation	F	Significance
Bunch length (cm)	Among groups	**3.319**	0.051
	Within a group		
	Total		
Bunch width (cm)	Among groups	**7.689**	0.002
	Within a group		
	Total		
Bunch mass (g)	Among groups	1.509	0.239
	Within a group		
	Total		
Stem mass	Among groups	**2.842**	0.076
	Within a group		
	Total		
Single berry mass	Among groups	**4.703**	0.018
	Within a group		
	Total		
Single seed mass	Among groups	**4.781**	0.017
	Within a group		
	Total		

LSD test determined the years when differences were observed in bunch length and width, as well as the stem mass, single berry and seed mass (Tables 3a and 3b).

Table 3a

Differences in grape mechanical properties determined by LSD test during the investigated years

Property	(I) Year	(J) Year	Difference (I-J)	Standard deviation	Significance
Bunch length (cm)	2009	2010	-1.230	0.607	0.053
		2011	**-1.450***	0.607	0.024
	2010	2009	1.230	0.607	0.053
		2011	-0.220	0.607	0.720

	2011	2009	**1.450***	0.607	0.024
		2010	0.220	0.607	0.720
Bunch width (cm)	2009	2010	**1.460***	0.372	0.001
		2011	0.710	0.372	0.067
	2010	2009	**-1.460***	0.372	0.001
		2011	-0.750	0.372	0.054
	2011	2009	-0.710	0.372	0.067
		2010	0.750	0.372	0.054
Bunch mass (g)	2009	2010	8.000	6.500	0.229
		2011	-2.900	6.500	0.659
	2010	2009	-8.000	6.500	0.229
		2011	-10.900	6.500	0.105
	2011	2009	2.900	6.500	0.659
		2010	10.900	6.500	0.105

Table 3b

Differences in grape mechanical properties determined by LSD test during the investigated years

Property	(I)Year	(J) Year	Difference (I-J)	Standard deviation	Significance
Stem mass (g)	2009	2010	0.05	0.221	0.819
		2011	**0.479***	0.221	0.039
	2010	2009	-0.051	0.221	0.819
		2011	0.428	0.221	0.063
	2011	2009	**-0.479***	0.221	0.039
		2010	-0.428	0.221	0.063
Single berry mass (g)	2009	2010	**0.241***	0.085	0.008
		2011	**0.205***	0.085	0.023
	2010	2009	**-0.241***	0.085	0.008
		2011	-0.036	0.085	0.676
	2011	2009	**-0.205***	0.085	0.023
		2010	0.036	0.085	0.676
Single seed mass (g)	2009	2010	**0.013***	0.004	0.005
		2011	0.007	0.004	0.111
	2010	2009	**-0.013***	0.004	0.005
		2011	-0.006	0.004	0.161
	2011	2009	-0.007	0.004	0.111
		2010	0.006	0.004	0.161

Grapevine varieties grown for the production of wine have different composition of bunch and berry. Skin is considered to be an important element of berry composition because it contains phenolic compounds which are extracted into wine and which give wine its color and aroma. According to numerous authors (Spayd et al., 1994; De la Hera et al., 2005; Downey et al., 2006) structure of one variety depends on the berry size and water availability in soil. Structural indicators for bunch and berry are given in Figures 3 and 4. Structure of a bunch consisted of 95.79% of berries, and 4.21% of stem. Fazinić et

al. (1989) determined that 2.74% of stem made one bunch and 97.93% were berries (5.82% - skin, 84.56% - mesocarp and 6.58% - seeds).

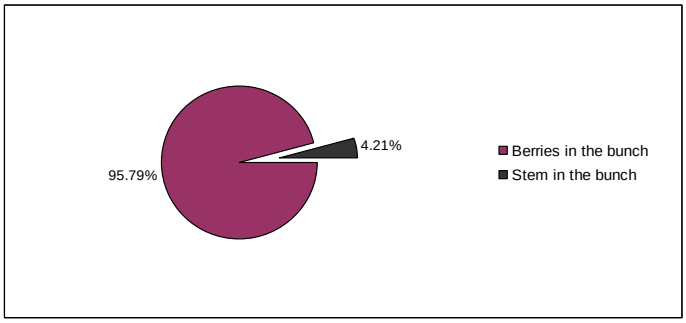


Figure 3. Elements of mechanical composition of a bunch (average 2010 - 2011)

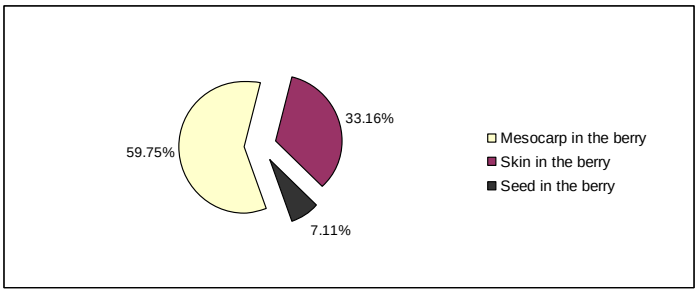
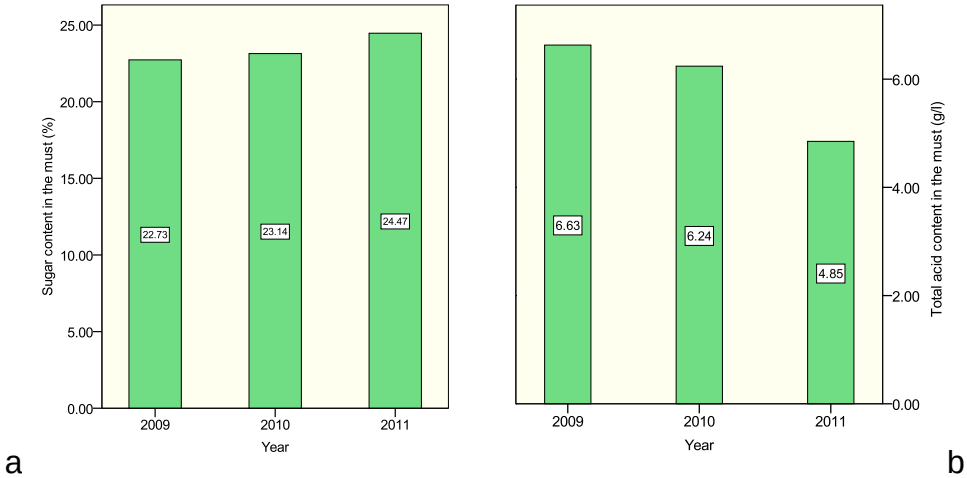


Figure 4. Elements of mechanical composition of berry (average 2010 - 2011)

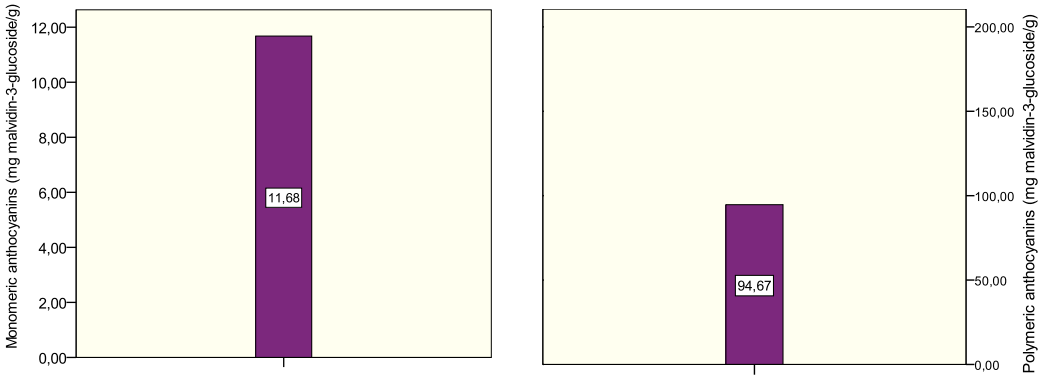


a b

Figure 5. Quality of Pinot Noir grape (average 2009 - 2011); a- Sugar content; b – Total acid content

As grape quality parameters, sugar and total acid contents varied with respect to the production years (Figure 5).

Quality of grape grown for wine production is also affected by phenolic compounds which composition depends on the grape variety, locality, climate, maturity stage of grapes. Quantity and chemical composition of phenolic compounds can be different with respect to the part of the bunch they are extracted from (Jordao et al., 2001). Pinot Noir grape grown in Vršac had different composition and concentration of phenolic compounds. The content of monomeric and polymeric anthocyanins in the berry skin is given in Figure 6.



a b

Figure 6. Content of monomeric (a) and polymeric (b) anthocyanins in grape berry skin of Pinot Noir variety (average 2009 - 2011)

Table 4

Correlation between total phenolic content and antioxidant activity in grape berry skin

Correlation		Total phenolic content (mg GAE/g)	Antioxidant activity (%)
Total phenolic content (mg GAE/g)	Pearsons´s correlation coefficient	1.00	**0.754****
	Significance		0.000
	N	18	18
Antioxidant activity (%)	Pearsons´s correlation coefficient	**0.754****	1.00
	Significance	0.000	
	N	18	18

**p<0.01; *p<0.05

Total phenolic contents affected the antioxidant activity. Positive correlation between total phenolic content in berry skin and antioxidant activity was determined (Table 4).

CONCLUSION

The year of investigation influenced almost all investigated elements of mechanical composition of bunch and berry of Pinot Noir variety:

- bunch length F (2.27) = 3.319, p = 0.051 (2009 differed from 2011);
- bunch width F(2.27) = 7.689, p = 0.002 (2009 differed from 2010);
- stem mass F(2.27) = 2,.842, p = 0.076 (2009 differed from 2011);
- single berry mass F(2.27) = 4.703, p = 0.018 (2009 differed from 2010 and 2011);
- single seed mass F(2.27) = 4.781, p = 0.017 (2009 differed from 2010).

Grape samples taken in the investigated years had similar sugar content in must and it ranged from 22.73% (2009), 23.14 (2010) to 24.47% (2011).

Average values of total acid content were almost equal in the investigated years (around 6 g/l), except in 2011 when the content of total acids was 4.85 g/l which was the lowest.

The content of monomeric and polymeric anthocyanins in berry skin was average, with concentrations of 11.68 and 94.67 mg of malvidin-3-glucoside/g.

High correlation was determined between total phenolic elements in the berry skin and antioxidant activity (r = 0.754, n = 18, p < 0.0005).

High quality of grapes was determined for grapevine variety Pinot Noir which was grown under agroecological conditions of Vršac.

Acknowledgments

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