

Acta Horticulturae et Regiotecturae – Special Issue  
Nitra, Slovaca Universitas Agriculturae Nitriae, 2016, pp. 30–34

## EFFECT OF SOME OENOLOGICAL PRACTICES APPLIED BEFORE THE ALCOHOLIC FERMENTATION ON THE CHEMICAL COMPOSITION AND SENSORY CHARACTERISTICS OF WHITE WINES

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The effect of the oenological practices, maceration and maceration with the addition of aromatic enzyme before the alcoholic fermentation on the composition, aromatic components and organoleptic profile of experimental wines from the local varieties Dimyat, Muscat Vrachanski and the newly-selected variety Plevenska Rosa was studied. The investigation was carried out during the period 2013–2014, with grapes and wine from the studied varieties grown in the soil and climatic conditions of the town of Pleven (Central Northern Bulgaria). The applied technological practices had increased the sugar-free extract and the total phenolic compounds content in the experimental samples. The highest rates for these indicators revealed the variants of Plevenska Rosa variety. The amount of esters and higher alcohols was greater in the wines obtained after maceration and maceration with the addition of aromatic enzyme in the grape must. The total esters concentration was the highest in the samples of the aromatic varieties Muscat Vrachanski and Plevenska Rosa. There was not observed a direct correlation between the applied oenological practices, enhancing the extraction and the aromatic components content in the experimental variants and their organoleptic profile.

**Keywords:** grapes, wine, maceration, aromatic enzyme, chemical composition, aromatic components, organoleptic profile

Wine is a drink with rich and diverse composition, containing a large number of substances and chemical compounds. Some of them pass from the grapes; others undergo transformations or are formed in the winemaking process.

Aroma is of great importance for the organoleptic profile of white wines; it is determined by the cumulative influence of a number of agro-biological and technological factors. The key role has the variety and its potential that could be emphasized or improved by certain oenological practices (Balik et al., 2002). The major part of the volatile aromatic components in wine is formed in the process of the alcoholic fermentation. Their synthesis depends on the medium composition, the clarity, the fermentation temperature and yeast strains (Killian and Ough, 1979; Houtman et al., 1980; Soles et al., 1982; Pereira and Pinto, 1998; Wondra and Berovic, 2001; Torrea et al., 2003; Yoncheva, 2011). Esters, higher alcohols and aldehydes have the largest share for the wine aroma formation (Pereira and Pinto, 1998; Camara et al., 1998). In Muscat wines the flavouring perceptions lead in assessing their quality and are primarily due to terpenes and their derivatives (Falque et al., 2001; Blagoeva et al., 2013).

Grape must maceration and the use of aromatic enzymes are common practices in the white wine production technology for enhancing the varietal flavour of the final product. The maceration at a higher temperature accelerates the extraction of terpenes from grape skins (Haygarov, 2012; Blagoeva et al., 2013). The enzyme preparations

with  $\beta$ -glucosidase activity support the degradation of glucosidic bonds in the molecules of non-volatile precursors of flavouring substances. That defines them as “aromatic-releasing” and their use results in increased concentration of free and bound terpenes in the grape must (Codresi et al., 2012; Lengyel et al., 2013).

The objective of the study was to investigate the effect of oenological practices maceration and maceration with the addition of aromatic enzyme before the alcoholic fermentation on the chemical composition, aromatic profile and organoleptic characteristics of white wine varieties Dimyat, Muscat Vrachanski and Plevenska Rosa.

### Material and methods

The study was carried out at the Institute of Viticulture and Enology (IVE) – Pleven, Bulgaria during the period 2013–2014. The object of the study were white wines from the old local varieties Dimyat, Muscat Vrachanski, and Plevenska Rosa variety selected by interspecies hybridization and distinguished for its practical resistance to diseases and low winter temperatures.

The vineyards were fruit-bearing, grown at the Experimental Base of the Institute. Muscat Vrachanski and Plevenska Rosa varieties were cultivated on stem Moser training while Dimyat variety on improved Guyot training. The loading at mature pruning of Dimyat was 18 winter eyes

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per vine, of Muscat Vrachanski – 28 winter eyes per vine, and of Plevenska Rosa – 24 winter eyes per vine.

During the period of grapes ripening (August–September) the dynamics of sugars accumulation was monitored through the changes in sugars and titratable acids concentration in the grape juice. Grapes were picked up upon reaching technological maturity and processed in the Experimental Winery of IVE – Pleven. The classic technology for dry white wine making was applied under the conditions of micro-vinification (Yankov et al., 1992) – crushing, draining, pressing, sulphitation (50 mg dm<sup>-3</sup> SO<sub>2</sub>), grape must clarification, adding of pure culture dry wine yeasts *Saccharomyces cerevisiae* Vitilevure B + C in the amount of 20 g/hl, fermentation temperature 20 °C, decantation, further sulphitation, storage.

The raw material of the studied varieties was divided into equal quantities into three technological variants, 30 kg each.

**1 variant** – control;

**2 variant** – maceration with the solid parts for 12 hours before the alcoholic fermentation;

**3 variants** – maceration with the solid parts for 12 hours with the addition of aroma-releasing enzyme Zymovarietal Aroma G at the rate of 3 g 100 kg<sup>-1</sup> before the alcoholic fermentation.

The grapes must chemical composition was determined as follows (Ivanov et al., 1979): sugars, g dm<sup>-3</sup> – airmeter of Dujardin; glucose, g dm<sup>-3</sup> – iodometric method; fructose, g dm<sup>-3</sup> – calculation method as the difference between sugar and glucose content; titratable acids (TA), g dm<sup>-3</sup> – titration with NaOH; pH – pH-meter; glucoacidometric index (GAI) – calculation method as the ratio of sugars (%) and TA (g dm<sup>-3</sup>).

The main indicators of wines chemical composition were analyzed by conventional methods in the wine-making practice (Ivanov et al., 1979): sugars, g dm<sup>-3</sup> – Schoorl's method; alcohol, vol. % – distillation method, Gibertini apparatus with densitometry of the distillate density; total extract (TE), g dm<sup>-3</sup> – Gibertini apparatus with densitometry, density of alcohol-free sample; sugar-free extract (SFE), g dm<sup>-3</sup> – calculation method (the difference between TE and sugars); titratable acids (TA), g dm<sup>-3</sup> – titration with NaOH; total phenolic compounds (TPC), g dm<sup>-3</sup> – method of Singleton et Rossi; pH – pH-meter.

The aromatic profile determination of the wines included the following indicators and methods of analysis (Ivanov et al. 1979): total aldehydes (mg dm<sup>-3</sup>) – bisulphate method; total esters (mg dm<sup>-3</sup>) – a method of saponification with

NaOH; total higher alcohols (mg dm<sup>-3</sup>) – modified method of Komarovsky – Felenber.

The organoleptic characteristics of the experimental samples were determined according to 100-score scale for the indicators: colour, aroma, taste and general impression (Prodanova, 2008) by a nine-member tasting committee.

## Results and discussion

The period of the study was characterized by various weather conditions during the grapes ripening stage. In 2013, the weather (hot summer, without rain) favoured the normal process of grapes maturing and determined better sugar accumulation, unlike in 2014, when the summer was cool and rainy. Upon reaching technological maturity, grapes were harvested and vinified. An analysis was made to identify the chemical composition of the must from the studied varieties. The results showed that the main indicators of the composition were within the normal range for the studied white wine grape varieties (Table 1).

The data presented in Table 1 showed that the grapes, vintage 2013, were distinguished by higher sugar content and lower titratable acids. This was more pronounced in the aromatic varieties Muscat Vrachanski and Plevenska Rosa. During the study period, the lowest sugar accumulation and respectively higher acidity were accounted for Dimyat variety. The ratio between the monosaccharides glucose and fructose was lower than 1, with quantitative predominance of fructose. The determined GAI values were indicative for the raw material quality. The calculated values for vintage 2013, were higher, as for Plevenska Rosa they reached 4.02, which demonstrated that grapes were suitable for the production of white wines with high quality, in terms of chemical composition and organoleptic characteristics. The reported pH rates were within the normal limits for white varieties.

Chemical and organoleptic analysis was performed of the obtained wines and the data for their chemical composition, aromatic profile and taste scores are presented in Table 2.

In all experimental wines, the alcoholic fermentation took place in full, as evidenced by their alcohol content and the residual sugars quantity. The alcohol concentration in the samples corresponded to the sugars in the grapes. For wines from both vintages, the lowest alcohol rate was recorded for the samples of Dimyat variety and the highest alcohol rate – Plevenska Rosa, without significant differences between the separate variants of varieties. The

**Table 1** Grape must chemical composition of the studied varieties.

Variety	Vintage	Date of harvest	Sugars (g dm <sup>-3</sup> )	Glucose (g dm <sup>-3</sup> )	Fructose (g dm <sup>-3</sup> )	Titratable acidity (g dm <sup>-3</sup> )	GAI	pH
Dimyat	2013	23.09.	184.00	88.80	95.20	6.58	3.18	3.27
	2014	15.09.	186.00	83.70	102.30	7.05	2.64	3.11
Muskat Vrachanski	2013	16.09.	198.00	84.80	113.20	5.73	3.46	3.26
	2014	15.09.	185.00	89.10	95.90	6.15	3.00	3.10
Plevenska Rosa	2013	29.08.	213.00	93.00	120.00	5.30	4.02	3.25
	2014	04.09.	198.00	83.70	114.30	5.88	3.37	3.27

**Table 2** Chemical composition, aromatic profile and tasting score of the experimental white wines from the studied varieties

Wine	variant	vintage	alcohol (vol. %)	total extract (g dm <sup>-3</sup> )	sugar (g dm <sup>-3</sup> )	sugar-free extract (g dm <sup>-3</sup> )	titratable acidity (g dm <sup>-3</sup> )	volatile acidity (g dm <sup>-3</sup> )	pH	TPC (g dm <sup>-3</sup> )	total esters (mg dm <sup>-3</sup> )	total aldehydes (mg dm <sup>-3</sup> )	total higher alcohols (mg dm <sup>-3</sup> )	tasting score
Dimyat	1	2013	12.19	19.00	1.00	18.00	6.30	0.66	3.27	0.30	70.40	156.40	293.50	76.67
		2014	12.47	20.80	1.96	18.84	6.60	0.68	3.07	0.26	70.40	42.40	324.00	76.60
	2	2013	12.27	19.80	1.30	18.50	5.33	0.60	3.35	0.36	88.00	123.60	330.00	77.22
		2014	12.37	20.80	1.46	19.34	6.73	0.66	3.19	0.33	88.00	51.40	348.00	75.80
Muskat Vrachanski	3	2013	12.33	19.40	1.27	18.10	5.40	0.54	3.32	0.43	105.60	91.00	356.50	76.33
		2014	12.48	21.40	1.15	20.25	6.78	0.66	3.13	0.48	123.20	89.30	428.00	73.60
	1	2013	12.53	19.00	1.64	17.36	5.40	0.54	3.25	0.39	123.20	145.30	325.00	80.22
		2014	12.34	19.80	1.23	18.57	6.08	0.36	3.01	0.29	88.00	44.70	378.00	74.00
Plevenska Rosa	2	2013	12.61	19.30	1.64	17.66	5.58	0.42	3.27	0.44	123.20	133.60	371.50	79.67
		2014	12.35	20.59	1.71	18.88	6.08	0.66	3.19	0.42	105.60	46.90	370.00	76.40
	3	2013	12.66	18.90	1.44	17.46	5.55	0.42	3.27	0.50	140.80	129.40	461.50	74.33
		2014	12.42	20.70	1.64	19.06	6.00	0.54	3.24	0.40	123.20	46.90	400.00	74.20
Plevenska Rosa	1	2013	12.68	19.30	1.64	17.66	4.95	0.48	3.33	0.54	105.60	163.74	397.50	76.33
		2014	12.56	19.20	1.40	17.80	5.25	0.66	3.16	0.38	140.80	111.70	235.00	80.80
	2	2013	12.75	20.10	1.64	18.46	4.15	0.48	3.36	0.56	193.60	147.00	373.00	74.78
		2014	12.54	19.70	1.17	18.53	4.73	0.48	3.46	0.42	158.40	158.50	244.00	78.00
Plevenska Rosa	3	2013	12.80	20.50	1.37	19.30	5.18	0.48	3.30	0.59	281.60	135.30	427.00	75.89
		2014	12.60	20.90	1.54	19.36	5.08	0.42	3.31	0.48	176.00	169.70	342.00	80.00

Note: Variant 1 – control. Variant 2 – maceration with the solid parts for 12 hours before the alcoholic fermentation. Variant 3 – maceration with the solid parts for 12 hours with the addition of flavour-releasing enzyme Zymovarietal Aroma G at the rate of 3 g/100 kg before the alcoholic fermentation

sugars content in the wines from vintage 2013 was in the range from 1.00 g dm<sup>-3</sup> to 1.64 g dm<sup>-3</sup>, and from vintage 2014 – from 1.15 to 1.96 g dm<sup>-3</sup>.

The quantity of titratable acids and sugar-free extract are of particular significance to the taste characteristics of wine as they determine respectively the freshness and density of taste.

The acid content of wines varied widely depending on the specificity of the variety (Table 2). Lower rates were accounted in the samples of the aromatic varieties. The highest acidity was recorded for the variants of Dimyat variety and the lowest of Plevenska Rosa that had explained the lack of enough freshness in their taste. The titratable acidity of the experimental wines, vintage 2013, ranged from 4.15 to 6.30 g dm<sup>-3</sup>, while for harvest 2014 – from 4.73 to 6.78 g dm<sup>-3</sup>. No significant differences were observed in the acid content between the separate variants of Muscat Vrachanski and Plevenska Rosa varieties. More significant differences were noticed between the variants of Dimyat. All experimental samples had normal volatile acidity.

More significant differences were found in the amount of sugar-free extract (SFE) of wines that also depended on the specific varietal features. For the samples of Dimyat variety, the rates of this indicator varied from 18.00 to 20.25 g dm<sup>-3</sup>, of Muscat Vrachanski variety – from 17.36 to 19.06 g dm<sup>-3</sup>, while for Plevenska Rosa variety from 17.66 to 19.36 g dm<sup>-3</sup>. Wines from the studied varieties, vintage 2014 had higher rate of SFE. The data showed that in all experimental samples, the SFE content was the lowest in variant 1 (the control) and increased in variants 2 and 3. These results reflected the positive effect of the applied technological practice maceration on SFE quantity. However, there was no correlation observed between the extract content of the wines and their tasting score. The variants containing higher SFE were not always rated higher in the organoleptic assessment (Table 2).

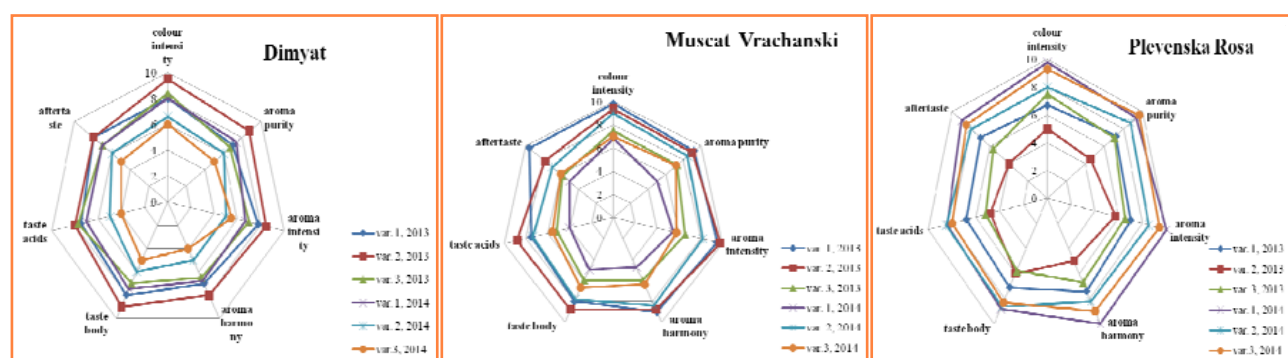
The phenolic compounds are a part of the substances forming wine extract, and therefore the same correlation was observed in their content as in SFE. In variants 2 and 3, the phenolic substances concentration was higher, confirming the effect of maceration on their content. However, unlike SFE, the amount of TPC in wines was higher in the variants of vintage 2013. Their content was also determined by the varietal specificity. Higher rates were reported in the samples from the aromatic varieties. The variants of Plevenska Rosa had the highest content of phenolic substances (Table 2).

The experimental results revealed the effect of the applied oenological practices maceration of the grape must and maceration with the addition of aromatic enzyme before the alcoholic fermentation on the aromatic profile of wines from the studied varieties. The esters, aldehydes and higher alcohols content in the samples depended both on the characteristics of the variety as well as on a number of technological factors.

The samples from the aromatic varieties Muscat Vrachanski and Plevenska Rosa exceeded significantly in quantity of total esters those obtained from Dimyat variety. In all experimental wines, the variants obtained by maceration and maceration with the addition of aromatic enzyme had more esters, as the highest concentrations were recorded in variants 3. This proved that the use of aroma-releasing enzyme improved the wine aroma as it had degraded the glycoside bonds in the molecules of the non-aromatic precursors. The experimental samples, vintage 2013, of Muscat Vrachanski (variant 1, 2 and 3) and Plevenska Rosa (variant 2 and 3) were distinguished by a higher concentration of the esters (Table 2). However, there was not found a correlation between the esters content in wines and their tasting score. That was probably due not only on the effect of their total amount, but also on the quantitative ratio between the different representatives.

The amount of total aldehydes in wines ranged from 91.00 to 163.74 mg dm<sup>-3</sup> (2013) and from 42.40 to 169.70 mg dm<sup>-3</sup> (2014), as there was not observed a negative impact of the higher concentrations on the organoleptic profile. The variants of Plevenska Rosa variety had the highest content of aldehydes. There was not found a direct correlation of the applied technological practices before fermentation and the amount of aldehydes in the samples, since it depended mainly on the type of the yeasts and the conditions of the process. All wines, vintage 2014, with the exception of variants 2 and 3 of Plevenska Rosa were characterized by significantly lower content of aldehydes (Table 2).

Maceration and the addition of enzyme in the grape must, however, lead to increased concentration of higher alcohols in the samples of all studied varieties. Their quantity varied in the range from 293.50 to 461.50 mg dm<sup>-3</sup> (2013) and from 235.00 to 428.00 mg dm<sup>-3</sup> (2014) as the control had the lowest concentration and variant 3 – the highest one (Table 2). The samples, vintage 2013, of Dimyat (variant 1, 2 and 3) and Muscat Vrachanski (variant 1) were characterized by lower content of higher alcohols, compared to the same



**Figure 1** Organoleptic profile of the experimental white wines from the studied varieties



samples from vintage 2014. Inverse correlation between the wines from both vintages was observed for Muscat Vrachanski (variant 2 and 3) and Plevenska Rosa (variant 1, 2 and 3). During tasting the variants of the studied varieties with a lower concentration of higher alcohols were more highly rated (Table 2).

The differences in the chemical composition of the experimental white wines, vintage 2013 and 2014, from the studied varieties reflected in their organoleptic profile (Figure 1). During tasting, the samples of the aromatic varieties Muscat Vrachanski and Plevenska Rosa were more highly evaluated. All experimental variants of Dimyat and Muscat Vrachanski varieties, vintage 2013, had better organoleptic characteristics compared to the respective samples, vintage 2014. However, the opposite tendency was observed for the variants of Plevenska Rosa variety. It has not been found a direct correlation between the technological practices aimed at improving the content of aromatic components in the wine and their organoleptic properties. The highest tasting scores had the control variants of Muscat Vrachanski, vintage 2013 – 80.22 points and Plevenska Rosa, vintage 2014 – 80.80 points that were distinguished with the best harmony between aroma and taste indicators.

### Conclusion

On the basis of the obtained results, the following could be concluded:

- Grapes of the studied varieties, vintage 2013, were characterized by better indicators for their composition. From the studied varieties the grape must of Dimyat variety had the lowest sugar content and the highest titratable acidity.
- The implementation of oenological practices: maceration and maceration with the addition of aroma-releasing enzyme increased SFE and TPC content of the experimental samples. The variants of Plevenska Rosa variety had the highest rates of these indicators.
- The addition of aroma-releasing enzyme had a positive impact on the amount of esters and higher alcohols in wines, but not on the aldehydes content. The total esters concentration was highest in the samples of the aromatic varieties Muscat Vrachanski and Plevenska Rosa.
- There was not found a direct correlation between the applied technological practices, enhancing SFE and TPC content and the aromatic components in the experimental variants and their organoleptic properties.

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