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Study of weather conditions influence on the grapes quality and some technological practices on the chemical composition, aromatic profile and organoleptic characteristics of white wines

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Abstract

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The influence of the technological practices of maceration and addition of aroma-releasing enzyme before the alcoholic fermentation on the chemical composition, aromatic profile and organoleptic characteristics of white wines from three consecutive harvests (2013, 2014 and 2015) was studied. The subject of the study were wines from the varieties Dimyat, Aligote, Muscat Ottonel, Misket Vrachanski and Plevenska Rosa, grown in the region of Pleven, Central Northern Bulgaria. The dynamics of grapes ripening and the weather conditions impact on the grapes composition and quality were monitored. Aligote was distinguished by the highest ratio of sugar accumulation, followed by Plevenska Rosa. Grapes from white aromatic varieties were characterized by lower total acidity compared to the non-aromatic. In the conditions of the experiments carried out, the maceration had an influence mainly on the chemical composition of the wines. These variants had higher rate of sugar-free extract and total phenolic compounds, but no higher tasting scores than the control. Positive impact of the maceration and the addition of aroma-releasing enzyme on the ratio of esters and higher alcohols in the samples was observed, but not on the aldehydes concentration. It was not found a strict correlation between the aromatic composition of the wines and their organoleptic characteristics. From the aromatic varieties, the variants containing more esters and fewer aldehydes and higher alcohols have been evaluated higher.

Keywords: wine; maceration; aroma-releasing enzyme; aromatic components; organoleptic characteristics

Introduction

The aromatic composition of each wine is individual, specific and distinctive depending on the variety, the region, the growing practices, the wine-making technology, the aging and storage conditions. All these factors have an impact on the overall formation of the unique wine profile. The aromatic perceptions (olfactory and taste) are most often prevalent in assessing white wines quality, especially those of Muscat varieties.

The wine aroma is a combination of a large number of volatile organic compounds in different concentrations. Some of them pass from the grapes where they are synthesized in the ripening process. During the alcoholic fermentation, the yeast, with its specific metabolism, also modifies and enriches the aromatic composition of the wine.

The nuances of the grape aroma (floral, fruit, spices, herbal) are mainly due to the terpenes and their derivatives. Approximately 50 representatives are found, as the dominant monoterpenes in the Muscat varieties being linalool, geraniol and nerol. Given their aroma of rose (fresh rose) and low threshold of sensation, they are a desired part of the aromatic complex of wines (Blagoeva et al., 2016). Lower rates of α-terpineol and β-citronellol are found responsible for the fruit and citrus hues (Slegers et al., 2017). The fermentation yeast strain also influences the terpenic composition of wine (Lengyel & Panaitescu, 2017).

Esters also have a significant role in the aromatic potential of wines. Some of them are the result of ongoing esterification processes during grapes ripening, others are produced by yeast, and others are formed while the wine ages. During the alcoholic fermentation, mainly ethyl and acetate esters are synthesized that define the fruity shades in the wine aroma. Their quantity and correlation depend entirely on the yeast metabolism and form the so-called “yeast bouquet” (Mendes et al., 2017; Samoticha et al., 2017).

The yeast and the fermentation conditions determine also the content of representatives from other groups of compounds that also participate in the wine aroma formation and affect it. Higher alcohols influence positively the aromatic profile of wines, unlike saturated fatty acids, especially hexanoic, octanoic and decanoic acids (Mendes et al., 2017; Samoticha et al., 2017). Acetaldehyde at high rates deteriorates the wine aroma. There are also norisoprenoids (β-damascenone, β-ionone) and volatile phenols (eugenol, p-vinylglycol) at lower rates both in grapes and wine (Slegers et al., 2017).

Certain natural and technological conditions are also determining for grapes and wine aromatic composition. Ponts et al. (2017) have studied the environmental factors and climatic changes impact on vine physiology, grapes ripening process, and the aromatic components formation and their precursors. Rodrigues et al. (2017) have pointed out the influence of terroir on the mineral composition and aromatic characteristics of the wine. The practices of maceration and addition of aromatic enzymes in the winemaking technology also positively influence and improve the flavor of the final product (Blagoeva et al., 2013). Enzyme preparations with β-glucosidase activity are defined as “aroma-releasing” as they promote the decomposition of the glycosidic bonds in the molecules of non-volatile aromatic precursors (Lengyel et al., 2013; Ovalle et al., 2018).

The objective of the study was to investigate the weather conditions impact on the grapes composition and the influence of the wine-making practices maceration and maceration with addition of aroma-releasing enzyme before the alcoholic fermentation on the chemical composition, aromatic profile and organoleptic characteristics of white wines from varieties, grown in the soil and climate conditions of the region of Pleven, Central Northern Bulgaria.

Material and Methods

The study was carried out at the Institute of Viticulture and Enology (IVE) – Pleven, Central Northern Bulgaria, in the period 2013-2015. The subject of the study were wines from the varieties Dimyat, Aligote, Muscat Ottonel, Misket Vrachanski and the hybrid variety Plevenska Rosa characterized by its enhanced practical resistance to diseases and low winter temperatures.

Pleven is located in the North Wine Region (the Danubian Plain) and is characterized by a typical continental climate, while the soils include all types of black soils.

The plantations were fruit-bearing, grown at the Institute’s Experimental Base. The varieties Aligote, Muscat Ottonel, Misket Vrachanski and Plevenska Rosa were grown on stem Moser training system while Dimyat was grown on improved ground Guyot training. The vine loading during summer pruning of Dimyat was 18 winter eyes per vine while of Aligote, Muscat Ottonel and Misket Vrachanski – 28 winter eyes per vine and of Plevenska Rosa – 24 winter eyes per vine.

During the grapes ripening (August-September), the dynamics of sugar accumulation was monitored through the changes in the sugars ratio (with refractometer) and the total acids (by titration) of the grape juice. Grapes were harvested upon reaching technological maturity and processed at the Experimental Winery of IVE – Pleven. The classic technology for white dry wines under the conditions of micro-vinification was applied (Yankov, 1992) – crushing, destamming, pressing, sulphuring (50 mg/dm^3 SO_2), must clarification, adding dry wine yeast *Saccharomyces cerevisiae Vitilevure B+C* (20 g/hl), fermentation temperature 20°C, racking, sulphuring to 30 mg/dm^3 of free SO_2, storage.

The grapes from the studied varieties were distributed evenly in three technological variants, each of 30 kg:

- V1 – the control
- V2 – maceration with the solid particles for 12 hours before the alcoholic fermentation
- V3 – maceration with the solid particles for 12 hours with addition of aroma-releasing enzyme *Zymovarietal Aroma G* (3 g/100 kg) before the alcoholic fermentation

Grapes must chemical composition was determined in accordance with the following methods (Ivanov et al., 1979): sugars, g/dm^3 – areometer of Dujardin; glucose, g/dm^3 – iodometric method; fructose, g/dm^3 – calculation method; total acids (TA), g/dm^3 – titration with NaOH; pH – pH-meter; glucoacidometric index (GAI) – calculation method as the ratio of sugars (%) and TA (g/dm^3).

The main indicators of the wine chemical composition were analyzed according to the methods commonly used in

Table 1. Probability (P%) of precipitation and average air temperature for the years of the study

Year		2013	2014	2015
$N_{(V-X)}$	P %	43 (Moderate wet)	14 (Very wet)	17 (Very wet)
$T°_{(V-X)}$		94 (Very cool)	97 (Very cool)	29 (Moderately hot)

P – probability, N – precipitations; T° – average air temperature

the wine-making practice (Ivanov et al., 1979; Chobanova, 2012): sugars, g/dm^3 – Schoorl method; alcohol, vol. % – distillation method, Gibertini apparatus with distillation densimeter; total extract (TE), g/dm^3 – Gibertini apparatus with densimeter for the alcoholic-free sample density; sugar-free extract (SFE), g/dm^3 – calculation method (the difference between TE and sugars); total acids (TA), g/dm^3 – titration with NaOH; total phenolic compounds (TPC), g/dm^3 – Singleton et Rossi method; pH – pH meter.

Wine aromatic profile included the following indicators and methods of analysis (Ivanov et al., 1979): total aldehydes (mg/dm^3) – bisulphite method; total esters (mg/dm^3) – saponification method with NaOH; total higher alcohols (mg/dm^3) – modified Komarovsky – Felenber method; free and glycosidically bound terpenes (mg/dm^3) – method of Dimitriadis and Williams (only for harvest 2013).

The organoleptic characteristics of the test samples were determined by a 100-score scale, per color, flavor, taste and general impression (Tsvetanov, 2001) by a 9-member tasting committee.

The value of each analyzed indicator of the composition of the experimental wines was average of the measurement of two parallel samples. If a significant difference was found in the values, a third sample was measured and the two closest values were taken into account. The tasting score of the experimental wines was average value of the committee members' assessment, eliminating the highest and the lowest.

The climatic characteristics of the years (Table 1) were determined by the methods of mathematical statistics (Sirakov, 1981).

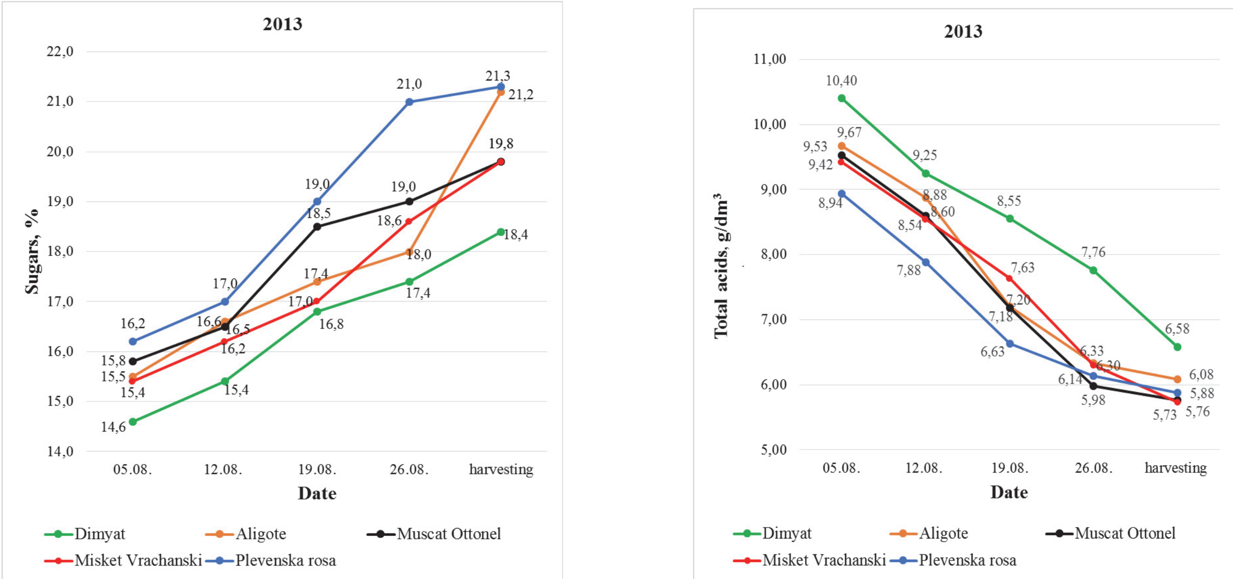
Results and Discussion

The sugar accumulation dynamics in the grapes of the studied varieties, during the ripening stage for the study period is shown in Figure 1 a, b, c. Significant influence of the weather conditions of the year on the process, the composition and the quality of the grapes has been established.

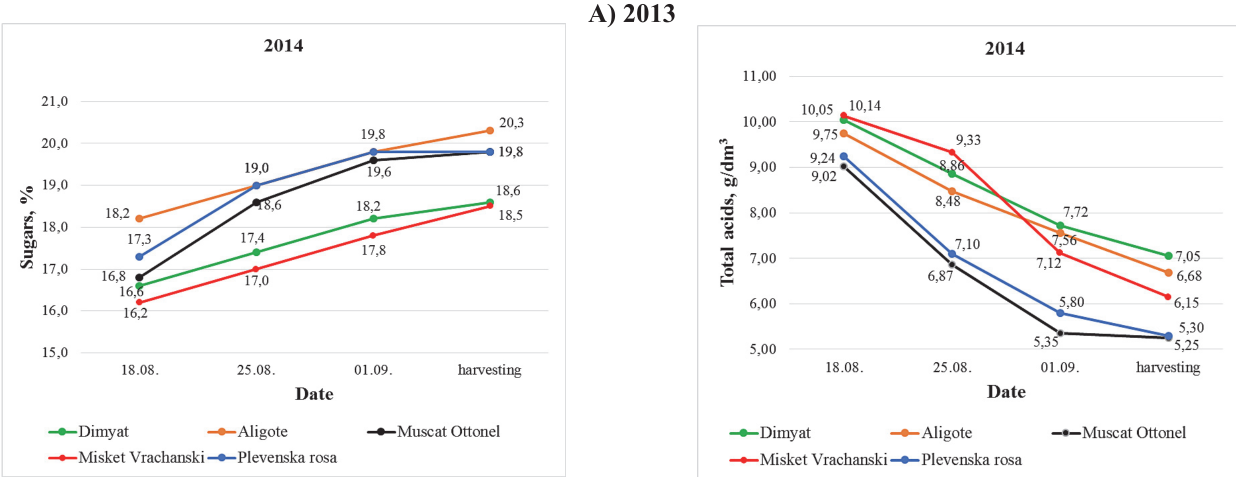
The data on the sugar and acid content changes in grapes, harvest 2013, are presented in Figure 1a and show a normal course of ripening. This was also due to the favorable climatic conditions during this period (July-August-September) – hot summer without precipitation. The high temperatures in August determined the good sugar accumulation and rapid reduction of the acids. In 2014, all varieties had a delayed season of ripening due to the adverse climatic factors during the cold and rainy summer period (Figure 1b). The preconditions created by the weather conditions for deterioration of the grapes sanitary condition necessitated earlier grape harvest to be undertaken. The sugar accumulation dynamics in 2015 is presented in Figure 1c. The graphic data show normal ripening in all varieties. The weather conditions change in September, in terms of lower temperatures, precipitation and hail, created prerequisites for worsening the grapes sanitary condition.

During the study period some regularity had been established. In all studied varieties from the beginning to the end of August there was a gradual increase of sugars – lower in the beginning and higher at the end of the month. Changes in total acids followed a reverse trend, with varying rates for the different varieties, depending on the weather conditions of the year. Their quantity went down most abruptly in Plevenska Rosa and Muscat Ottonel. They reached the fastest technological maturity, and respectively their grapes were harvested the earliest, at the end of August or early September. For the rest of the varieties, the sugars accumulation and the acids reduction was taking place at a slower pace, respectively the technological maturity occurred later and the grapes were harvested in mid September. The latest ripening variety was Dimyat.

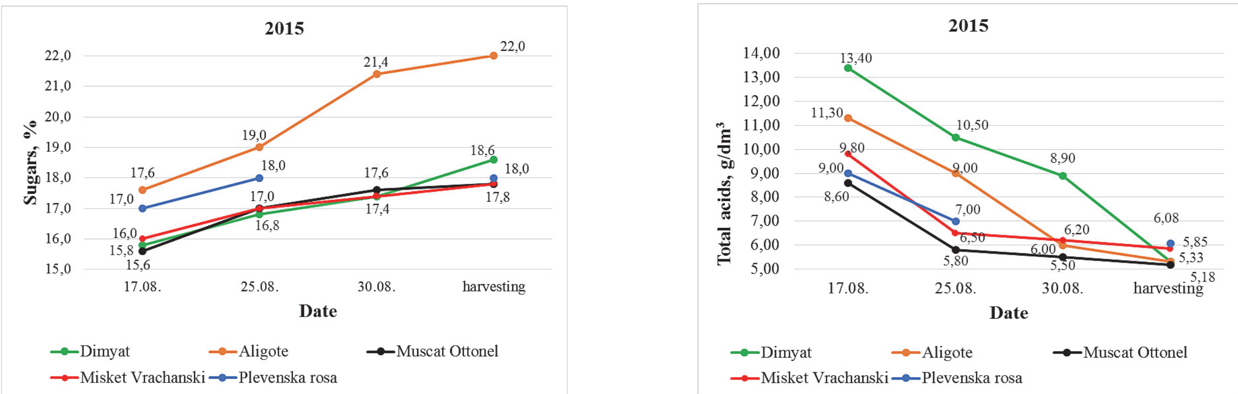
The data on the grape must composition are presented in Table 2. During the study period, Aligote variety was distinguished with the highest sugar accumulation, followed by Plevenska Rosa and Muscat Ottonel. However, some differences were observed in this trend during the various years. In 2013, the sugars in the grapes from the studied varieties varied from 184.00 to 213.00 g/dm^3, as the highest ratios were recorded in Aligote and Plevenska Rosa, and the lowest – in Dimyat. In harvest 2014, the highest sugar content had Aligote (203.00 g/dm^3), followed by Muscat Ottonel and Plevenska Rosa (198.00 g/dm^3). The lowest sugar content had Dimyat (186.00 g/dm^3) and Misket Vrachanski (185.00 g/dm^3). In 2015 again the highest sugar ratio was recorded in Aligote (220.00 g/dm^3), followed by Dimyat (186.00 g/dm^3) and Plevenska Rosa (180.00 g/dm^3). Muscat Ottonel and Misket Vrachanski had the lowest sugar content (178.00 g/dm^3). The content of the monosaccharides glucose and fructose was also determined in the grape juice of all varieties. Their ratio was less than 1, however the fructose was prevailing in quantity.



A) 2013



B) 2014



C) 2015

Fig. 1. Changes in sugars (%) and total acids (g/dm^3) during the ripening period of the studied varieties

Table 2. Chemical composition of the grapes must from the studied varieties

Variety \ Indicators	Vintage	Date of harvest	Sugars, g/dm³	Glucose, g/dm³	Fructose, g/dm³	Total acids, g/dm³	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
	2015	17.09.	186.00	83.58	102.42	5.33	3.49	3.16
Aligote	2013	11.09.	212.00	98.00	114.00	6.08	3.32	3.24
	2014	11.09.	203.00	90.00	113.00	6.68	3.04	3.11
	2015	10.09.	220.00	91.58	128.42	5.33	4.13	3.17
Muscat Ottonel	2013	29.08.	198.00	82.00	116.00	5.76	3.44	3.26
	2014	03.09.	198.00	82,00	116.00	5.25	3.77	3.27
	2015	01.09.	178.00	87.08	90.92	5.18	3.28	3.21
Misket 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
	2015	01.09.	178.00	93.38	84.62	5.85	3.04	3.05
Plevenska Rosa	2013	29.08.	213.00	93.00	120.00	5.88	3.62	3.25
	2014	04.09.	198.00	83.70	114.30	5.30	3.73	3.27
	2015	26.08.	180.00	86.50	93.50	6.08	3.17	2.96

With regard to total acid content, the data showed lower acidity in the aromatic varieties compared to the non-aromatic ones, which is their varietal specificity (Table 2).

In the grapes from the aromatic varieties (2013 harvest) close rates of total acids (below 6.00 g/dm³) were recorded, unlike Dimyat and Aligote, where they were respectively 6.58 and 6.08 g/dm³. In 2014, the acidity in the must ranged from 5.25 (Muscat Ottonel) to 7.05 g/dm³ (Dimyat) and in 2015 from 5.18 (Muscat Ottonel) to 6.08 g/dm³ (Plevenska Rosa). In 2015, the trend of the previous two vintages – lower acidity in grapes from the aromatic varieties, compared to non-aromatic, was not observed.

Based on the established content of sugars and total acids in the grapes of the studied varieties the glucoacidimetric indicator (GAI) for each one of them was determined. Its rates were indicative of the grapes quality and its use in winemaking. The calculated rates for 2013 harvest were higher than 3, proving that the grapes were suitable for the production of wines of optimal quality with regard to the chemical composition and the tasting features. For 2014 harvest, the rates were within the range from 2.64 (Dimyat) to 3.77 (Muscat Ottonel), i.e. the grapes not from all varieties, had good enough indicators for the production of quality wines. GAI for 2015 harvest was from 3.04 (Misket Vrachanski) to 4.13 (Aligote), showing the good characteristics of the grapes to obtain wines with optimal composition and organoleptic profile (Table 2).

Upon completion of the alcoholic fermentation, a chemical and organoleptic analysis of the wines obtained from the experimental variants was carried out, and their composition and tasting data are presented in Table 3.

The alcohol content of the samples varied over a wide range. The highest ratio was recorded in Plevenska Rosa wines (from 12.54 to 12.80 vol. %), followed by Aligote wine (from 12.40 to 12.78 vol. %) and the lowest alcohol content had the samples of Dimyat (from 11.70 to 12.48 vol. %). The results revealed that from the wines made from the non-aromatic varieties Dimyat and Aligote the lowest alcohol content had 2015 harvest samples, while from the wines from the aromatic varieties Muscat Ottonel, Misket Vrachanski and Plevenska Rosa, the lowest alcohol content had 2014 harvest samples. The differences in the alcohol content were not significant between the individual variants of the studied varieties per vintages. From the analytical results, it could be seen that for all varieties, 2013 harvest, the wines from V1 had the lowest alcohol rates. V2 and V3 showed gradual rise of alcohol. In the following year, only the tendency for V3 samples to have the highest alcohol concentration remained. In 2015 only in Dimyat and Muscat Ottonel wines the highest alcohol was recorded in the samples of V3.

The differences in the amount of sugars in the experimental wines were more significant. In all samples, the process of alcoholic fermentation had taken place completely, without deviations from the normal course. That was confirmed by the residual sugars content ranging from 1.00 to 1.81 g/dm³ (2013), from 0.94 to 2.49 g/dm³ (2014) and from 1.00 to 2.16 g/dm³ (2015).

The sugar-free extract (SFE) was an important indicator for the wine composition as it also related to their tasting qualities. Its rates were within the specific ranges for white wines of the respective varieties. The data presented in Table 3 revealed that from all experimental wines of the studied

Table 3. Chemical composition of the experimental wines from the studied varieties

Indicators / Wine	Variant	Vintage	Alcohol, vol. %	Total extract, g/dm³	Sugar, g/dm³	Sugar-free extract, g/dm³	Total acids, g/dm³	Volatile acids, g/dm³	pH	TPC, g/dm³	Tasting score
Dimyat	V1	2013	12.19	19.00	1.00	18.00	6.30	0.66	3.27	0.36	76.67
		2014	12.47	20.80	1.96	18.84	6.60	0.68	3.07	0.26	76.60
		2015	11.70	18.80	1.08	17.46	5.15	0.68	3.06	0.56	72.43
	V2	2013	12.27	19.80	1.30	18.50	5.33	0.60	3.35	0.30	77.22
		2014	12.37	20.80	1.46	19.34	6.73	0.66	3.19	0.33	75.80
		2015	11.72	19.00	1.34	17.92	5.13	0.62	3.17	0.51	74.57
	V3	2013	12.33	19.40	1.27	18.10	5.40	0.54	3.32	0.43	76.33
		2014	12.48	21.40	1.15	20.25	6.78	0.66	3.13	0.48	73.60
		2015	11.76	20.10	1.00	19.10	5.23	0.64	3.11	0.60	73.29
Aligote	V1	2013	12.70	19.10	1.81	17.29	5.70	0.54	3.10	0.48	79.56
		2014	12.69	20.10	2.49	17.61	6.28	0.48	3.08	0.25	77.20
		2015	12.59	20.20	1.94	18.26	5.20	0.66	3.03	0.45	75.43
	V2	2013	12.72	18.60	1.27	17.33	5.40	0.54	3.31	0.52	75.89
		2014	12.61	19.90	1.93	17.97	6.00	0.52	3.28	0.24	73.60
		2015	12.53	20.78	1.20	19.58	4.20	0.42	3.15	0.37	72.71
	V3	2013	12.78	19.40	1.78	17.62	5.33	0.42	3.27	0.57	75.00
		2014	12.73	20.10	2.00	18.10	6.38	0.56	3.19	0.29	79.50
		2015	12.40	22.22	2.02	20.20	4.80	0.54	3.19	0.39	73.43
Muscat Ottonel	V1	2013	12.50	19.00	1.74	17.26	5.10	0.42	3.22	0.36	78.22
		2014	12.54	19.20	1.00	18.20	5.00	0.36	3.00	0.35	78.40
		2015	12.60	21.16	1.54	19.62	5.18	0.62	3.11	0.30	77.29
	V2	2013	12.60	19.20	1.44	17.76	5.25	0.48	3.30	0.44	77.00
		2014	12.53	19.60	0.94	18.66	5.13	0.48	3.15	0.39	77.80
		2015	12.63	21.97	1.23	20.74	4.90	0.62	3.26	0.27	79.14
	V3	2013	12.68	19.30	1.64	17.66	5.43	0.42	3.36	0.40	75.89
		2014	12.58	20.04	1.20	18.84	5.05	0.42	3.15	0.36	78.40
		2015	12.68	22.40	1.17	21.23	4.53	0.66	3.23	0.24	78.71
Misket Vrachanski	V1	2013	12.53	19.00	1.64	17.36	5.40	0.54	3.25	0.39	80.22
		2014	12.34	19.80	1.23	18.57	6.08	0.36	3.01	0.29	74.00
		2015	12.55	21.30	2.16	19.14	5.65	0.60	3.07	0.43	81.14
	V2	2013	12.61	19.30	1.64	17.66	5.58	0.42	3.27	0.44	79.67
		2014	12.35	20.59	1.71	18.88	6.08	0.66	3.19	0.42	76.40
		2015	12.67	22.60	2.00	20.60	5.45	0.62	3.25	0.34	73.43
	V3	2013	12.66	18.90	1.44	17.46	5.55	0.42	3.27	0.50	74.33
		2014	12.42	20.70	1.64	19.06	6.00	0.54	3.24	0.40	74.20
		2015	12.47	22.20	1.50	20.70	5.25	0.66	3.21	0.36	72.71
Plevenska Rosa	V1	2013	12.68	19.30	1.64	17.66	4.95	0.48	3.33	0.54	76.33
		2014	12.56	19.20	1.40	17.80	5.25	0.66	3.16	0.38	80.80
		2015	12.60	23.08	1.62	21.46	5.70	0.42	3.05	0.46	83.29
	V2	2013	12.75	20.10	1.64	18.46	4.15	0.48	3.36	0.56	74.78
		2014	12.54	19.70	1.17	18.53	4.73	0.48	3.46	0.42	78.00
		2015	12.65	23.00	1.42	21.58	5.00	0.54	3.22	0.47	73.29
	V3	2013	12.80	20.50	1.37	19.30	5.18	0.48	3.30	0.59	75.89
		2014	12.60	20.90	1.54	19.36	5.08	0.42	3.31	0.48	80.00
		2015	12.62	22.90	1.22	21.68	5.03	0.48	3.18	0.36	75.14

varieties, 2015 harvest samples had the highest SFE content. An exception was only observed for Dimyat. During the study period there was no constant trend for this indicator content in the experimental wines. From the inter-varietal variants (2013) the highest SFE had Dimyat samples (from 18.00 to 18.50 g/dm^3) and Plevenska Rosa (from 17.66 to 19.30 g/dm^3). The variants of Aligote, Muscat Ottonel and Misket Vrachanski had significantly lower SFE. In 2014, the tendency was preserved as the highest SFE had Dimyat samples again (from 18.84 to 20.25 g/dm^3) and the lowest – the variants of Aligote (from 17.61 to 18.10 g/dm^3).

A reverse trend was observed, however, for the next harvest – the highest SFE had the variants of Plevenska Rosa (from 21.46 to 21.68 g/dm^3), followed by Muscat Ottonel (from 19.62 to 21.23 g/dm^3), and the lowest – of Dimyat (from 17.46 to 19.10 g/dm^3). The SFE content in wines from the aromatic varieties Muscat Ottonel, Misket Vrachanski and Plevenska Rosa was similar. The presented results showed that V1 of all studied varieties had the lowest rates for this indicator (Table 3).

In 2013, from Dimyat, Muscat Ottonel and Misket Vrachanski, the highest SFE had V2, and from Aligote and Plevenska Rosa – V3. For the next harvests (2014 and 2015), the lowest rate of SFE was in V1 and the highest in V3. The reason was the impact of the technological practice of maceration, where as a result of the longer contact with the solids, the extraction processes were accelerated and the must was enriched with substances involved in the formation of the wine sugar-free extract. A proportional dependence between the quantity of SFE and the sample tasting scores was not established from the presented experimental data. The variants with higher extraction content were evaluated with a lower score in the organoleptic analysis (Table 3). The reason was the complex influence of other indicators on the wine tasting characteristics.

In the experimental samples the total acids also varied within the typical range for white wines and corresponded to the specifics of the variety. Generally, lower rates were observed in the wines from the aromatic varieties. For 2013 harvest, the lowest acids were recorded in the variants of Plevenska Rosa (4.15 to 5.18 g/dm^3), and the highest in V1 of Dimyat (6.30 g/dm^3). In the rest of the samples the acidity was in the range from 5.10 (Muscat Ottonel, V1) to 5.70 g/dm^3 (Aligote, V1). No strict dependence of the total acidity was found between the individual variants of the varieties. In Dimyat and Aligote the highest acid content was recorded in V1, in Misket Vrachanski – in V2, and in Muscat Ottonel and Plevenska Rosa – in V3. The total acids of the experimental samples, 2014 harvest, ranged widely from 4.73 to 6.78 g/dm^3. Dimyat samples had distinctively the highest rates. The lowest acidity was recorded in Muscat Ottonel and Plevenska Rosa wines. The 2015 harvest wines had the lowest acidity – from 4.20 (Aligote, V2) to 5.70 g/dm^3 (Plevenska Rosa, V1), as higher values were recorded for the aromatic varieties.

The results revealed that the applied technological practices did not affect the rates of the investigated indicator. The amount of total acids had an effect on the white wines taste, determining their freshness. However, there was no strict correlation between the acidity of the samples and their organoleptic evaluation, both between the varieties and their variants (Table 3). The variants of Dimyat, Muscat Ottonel and Misket Vrachanski (2013) containing less total acids were evaluated higher. For the other harvests (2014 and 2015), the higher acidity, respectively freshness in the taste, was positively evaluated by the tasting committee (Aligote, Misket Vrachanski, Plevenska Rosa).

All experimental white wines had a normal volatile acidity ranging from 0.42 to 0.66 g/dm^3 (2013), from 0.36 to 0.68 g/dm^3 (2014) and 0.42 to 0.68 g/dm^3 (2015) that did not worsen their organoleptic qualities (Table 3).

The concentration of total phenolic compounds (TPC) in the experimental samples was in the typical ranges for white wines – from 0.36 to 0.59 g/dm^3 (2013), from 0.24 to 0.48 g/dm^3 (2014) and from 0.24 to 0.60 g/dm^3 (2015). During the study period, unidirectional results were not observed. The lowest and the highest TPC content in 2013 was recorded in the variants of Dimyat and Plevenska Rosa respectively, in 2014 – in the variants of Aligote and Plevenska Rosa, in 2015 – in the variants of Muscat Ottonel and Dimyat. The results showed that in most cases in the samples of the studied varieties there was a gradual increase in the TPC rate from V1 to V3. That was a consequence of the maceration that accelerated the extraction processes between the must and the solids. The TPC content in wine influenced its taste. However, the experimental data did not show a correlation with the scores obtained in the organoleptic analysis (Table 3).

The data on the aromatic composition of the experimental white wines during the study period showed significant differences between the samples obtained from the aromatic and non-aromatic varieties (Table 4).

The amount of the total esters was the lowest in Dimyat samples (2013: from 70.40 to 105.60 mg/dm^3; 2014: from 70.40 to 123.20 mg/dm^3; 2015: from 88.00 to 216.80 mg/dm^3) and increased in the order Muscat Ottonel, Misket Vrachanski, Aligote and Plevenska Rosa (2013); Aligote, Misket Vrachanski, Muscat Ottonel and Plevenska Rosa (2014); Aligote, Muscat Ottonel, Plevenska Rosa, Misket Vrachanski (2015). The highest concentrations were recorded in the variants of Plevenska Rosa (2013 and 2014) and Misket Vra-

Table 4. Aromatic composition of the experimental wines from the studied varieties

Indicators / Wine	Variant	Vintage	Total esters, mg/dm^3	Total aldehydes, mg/dm^3	Total higher alcohols, mg/dm^3
Dimyat	V1	2013	70.40	156.40	293.50
		2014	70.40	42.40	324.00
		2015	88.00	35.20	99.00
	V2	2013	88.00	123.60	330.00
		2014	88.00	51.40	348.00
		2015	124.00	72.60	196.00
	V3	2013	105.60	91.00	356.50
		2014	123.20	89.30	428.00
		2015	216.80	79.20	228.00
Aligote	V1	2013	105.60	104.0	281.50
		2014	88.00	53.60	360.00
		2015	176.00	52.80	194.0
	V2	2013	123.20	130.30	301.50
		2014	105.60	44.70	404.00
		2015	212.20	106.00	346.00
	V3	2013	140.80	78.10	305.00
		2014	123.20	51.40	377.00
		2015	246.00	52.80	346.00
Muscat Ottonel	V1	2013	140.80	168.60	343.00
		2014	105.60	42.40	356.00
		2015	176.00	52.80	247.00
	V2	2013	176.00	146.40	389.50
		2014	140.80	67.00	392.00
		2015	211.20	30.80	300.00
	V3	2013	193.60	118.30	404.50
		2014	158.40	67.00	392.00
		2015	246.40	44.00	414.00
Misket Vrachanski	V1	2013	123.20	145.30	325.00
		2014	88.00	44.70	378.00
		2015	176.00	57.20	324.00
	V2	2013	123.20	133.60	371.50
		2014	105.60	46.90	370.00
		2015	299.20	70.40	304.00
	V3	2013	140.80	129.40	461.50
		2014	123.20	46.90	400.00
		2015	316.80	44.00	444.00
Plevenska Rosa	V1	2013	105.60	163.74	397.50
		2014	140.80	111.70	235.00
		2015	193.60	81.40	270.00
	V2	2013	193.60	147.00	373.00
		2014	158.40	158.50	244.00
		2015	211.20	55.00	275.00
	V3	2013	281.60	135.30	427.00
		2014	176.00	169.70	342.00
		2015	264.00	39.60	320.00

chanski (2015). The influence of the applied technological practices on the esters content in wines was confirmed. Their rates increased compared to the control in the order: V1 < V2 (maceration) < V3 (maceration and addition of aroma-releasing enzyme). The reason was that part of the esters was formed as a result of the esterification processes occurring during the grapes ripening and others – from the yeast during the alcoholic fermentation.

The total aldehydes content in the experimental wines varied within the range of: for 2013 harvest from 78.10 (Aligote, V3) to 168.60 mg/dm^3 (Muscat Ottonel, V1), for 2014 harvest from 42.40 (Dimyat, V1 and Muscat Ottonel, V1) to 169.00 mg/dm^3 (Plevenska Rosa, V3) and for 2015 harvest from 30.80 (Muscat Ottonel, V2) to 106.00 mg/dm^3 (Aligote, V2). In 2013, higher rates were found in the samples of the aromatic varieties. In all experimental wines, the highest values were recorded in the control variants, with the exception of Aligote. In 2014 the aldehydes content was lower in the variants of Misket Vrachanski, and the highest – of Plevenska Rosa, however that did not have a negative impact on their organoleptic profile. In wines 2015 harvest, the total aldehydes were the lowest. There was no influence of the used technological practices on the aldehydes rate as they were mainly synthesized during the alcoholic fermentation as a product of the yeast metabolism and their content in the grapes just was traceable.

The higher alcohols rate in the samples varied widely from 281.50 to 461.50 mg/dm^3 (2013), from 235.00 to 428.00 mg/dm^3 (2014) and from 99.00 to 444.00 mg/dm^3 (2015). The results obtained for the study period did not reveal similar trends. For 2013 harvest, the data showed higher rates in the wines from the aromatic varieties Muscat Ottonel, Misket Vrachanski and Plevenska Rosa. For 2014 harvest, the lowest rates were found in the variants of Plevenska Rosa and in 2015 harvest – in Dimyat samples. The higher alcohols were mainly the product of the yeast metabolism, but the results in Table 4 showed that the control had the lowest concentrations from all samples with the exception of Misket Vrachanski (2014 and 2015). The higher alcohols rate gradually went up in V2 and V3, which was probably influenced by the applied technological practices in the set trials, i.e. there was an increased extraction of amino acids during the maceration, that were the precursors for the synthesis of the higher alcohols from the yeast metabolism on Ehrlich's path.

The ratio of free and glycosidically bound terpenes was also determined in the experimental white wines from vintage 2013. They were mainly formed during the grapes ripening. The results did not demonstrate any significant effect of the maceration and the addition of aroma-releasing enzyme on their concentrations in the samples (Figure 2). The highest rate of free terpenes was found in the variants of Misket Vrachanski – from 0.327 (V2) to 0.382 mg/dm^3 (V3), and the lowest in Aligote samples from 0.217 (V1) to 0.280 mg/dm^3 (V3). The content of glycosidically bound terpenes in the wines was significantly higher and revealed a similar trend as of the free ones. The highest rates were accounted in Misket Vrachanski samples – from 0.524 (V2) to 0.622 mg/dm^3 (V3), followed by the variants of Plevenska Rosa.

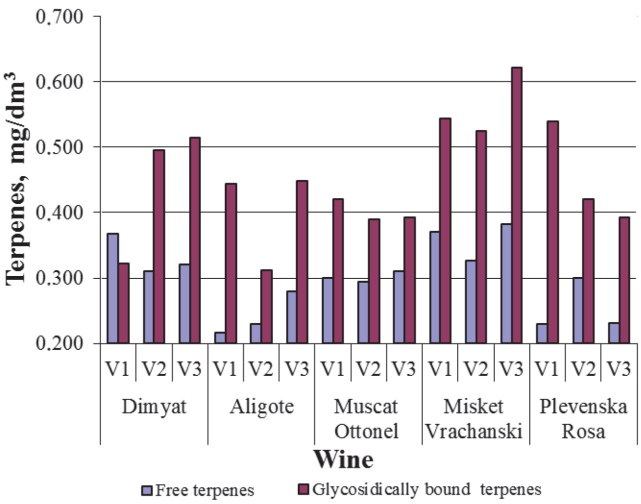


Fig. 2. Terpenes content of the experimental wines, vintage 2013

The analysis results of the wines aromatic composition did not show a strict correlation between the studied components and the organoleptic profile, respectively the tasting evaluation (Table 3, Table 4). It should be outlined that the variants of the aromatic varieties containing more esters and fewer aldehydes and higher alcohols were scored higher: Muscat Ottonel – 79.14 points (V2, 2015), Misket Vrachanski – 81.14 points (V1, 2015) and Plevenska Rosa – 83.29 points (V1, 2015). From Dimyat and Aligote wines, the variants that were defined as the best, contained fewer esters and more aldehydes and higher alcohols – Dimyat – 77.22 points (V2, 2013), Aligote – 79.56 (V1, 2013).

Conclusions

From the studied varieties, grown in the region of Pleven, Plevenska Rosa and Muscat Ottonel were the earliest ripening varieties and Dimyat – the latest.

Aligote was distinguished with the highest sugar accumulation, followed by Plevenska Rosa. The grapes from the aromatic varieties were characterized by lower total acidity compared to the non-aromatic.

Under the conditions of the experiment the maceration had mainly an effect on the wine chemical composition – the respective variants had higher SFE and TPC rates, but no higher tasting scores than the control.

It was found a positive influence of the applied technological practices of maceration and addition of aroma-releasing enzyme on the content of esters and higher alcohols in the wines, but not on the aldehydes rate.

There was no strict dependence between the studied aromatic compounds of the wines and their tasting evaluation. From the aromatic varieties, the variants containing more esters and fewer aldehydes and higher alcohols have been evaluated higher.

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