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Original article

Study of the Technological Characteristics of the White Wine Varieties Tamyanka, Slava and Druzhba, Grown in the Kyustendil Region (Bulgaria)

Tatyana Yoncheva [a,*] & Simeon Krumov [b]

[a] Agricultural Academy, Institute of Viticulture and Enology, Pleven, Bulgaria
[b] Agricultural Academy, Institute of Agriculture, Kyustendil, Bulgaria

Abstract

The study of the technological characteristics of the white varieties Tamyanka, Slava and Druzhba in the Kyustendil region was carried out during four consecutive harvests (2021 – 2024). The climatic factors in the growing region were monitored annually for the period of the study. The grapes were harvested upon reaching optimal maturity for each variety. It was found that the sugar content in the grapes depended on the varietal specifics and the weather conditions of the year. The variety with the best sugar accumulation and the earliest grape harvest was Tamyanka. The lowest sugars and titratable acidity were found in the Druzhba variety. The classical scheme for the production of white dry wines was applied for processing and vinification of the grapes. The obtained experimental wines had a chemical composition without deviations from the normal ranges of the studied indicators. The alcohol concentration was in line with the sugar accumulation in the grapes per variety and harvest. The Tamyanka samples had the highest extract content and titratable acidity. The quantity of phenolic compounds in the wines of the studied varieties was similar. Their sensory characteristics corresponded to the varietal features. In the organoleptic analysis, the samples with the highest tasting ratings were the Tamyanka variety, followed by Slava, and the lowest rated were those of the Druzhba variety.
Keywords: Tamyanka, Slava, Druzhba, Grapes, Wine, Chemical Composition, Sensory Characteristics.

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* **Corresponding author:**

Tatyana Yoncheva is an associate professor at the Department of Vine Selection, Enology and Chemistry at the Institute of Viticulture and Enology - Pleven, Bulgaria, Agricultural Academy. Her research interests include Wine technology, Wine microbiology, Grapes and wine chemical composition, Grapes and wine antioxidant activity, Wine sensory analysis. She has lived and worked in Pleven, Bulgaria.
Email: t_ion@abv.bg

INTRODUCTION

The composition, quality and characteristics of grapes and wines from white grape varieties depend on the complex influence of many factors. Of great importance are the varietal specifics, the terroir conditions in the growing area, the applied agricultural and oenological practices.

Each wine-growing region is identified by specific natural conditions that form the respective terroir. The terroir, with its geographical and soil - climatic conditions, is of key importance for the main biochemical indicators of grapes and wine. The most important factors for the cultivation of certain varieties in a given region are the climate and soils. Their favourable combination with the characteristics and specifics of the variety guarantees higher yields, as well as obtaining better quality and quantity of production (Leeuwen, 2010; Ferretti and Febbroni, 2022).

Grapevine is a crop, very susceptible to the climatic environment. This requires good knowledge of the bioclimatic characteristics of the variety and the possibility of favourable cultivation in the conditions of a certain region. The meteorological conditions in a certain year and for a given area (air temperature, amount of precipitation, duration of sunshine) show a strong impact on the plant phenology, the ripening process, the composition and quality of the grape harvest. The soil influence is mainly related to its supply of assimilable nitrogen and water balance. Light, containing sufficient mineral nutrients, deep, permeable soils are the most suitable for vineyards, where the plant roots could reach great depths and ensure its rapid development (Katerov et al., 1990; Leeuwen et al., 2023; Ferretti and Febbroni, 2022).

The technological characteristics of the variety include indicators such as the mechanical structure of the cluster and berry, chemical composition and organoleptic qualities of the grape and wine, which are determined both by the genetic potential and characteristics of the variety, and by the application of various agricultural practices in its cultivation (Friedel et al., 2015). The diverse chemical composition of the grape is also influenced by the terroir conditions in the growing region. The main components are sugars and titratable acids, the content and ratio of which depends primarily on its degree of maturity. In white varieties, the grape is harvested at a sugar ratio of 18-20% and a titratable acidity of 5-7 g/l, which ensures the production of wines with optimal composition and quality (Chobanova, 2012).

The white wines properties are also influenced by the technology used for grape processing and vinification. The alcoholic fermentation conditions (Garcia et al., 2019; Samoticha et al., 2019), the application of maceration with or without the use of enzymes (Esti and Tamborra, 2005; Jagatić Korenika et al., 2018; Tomašević et al., 2019), the subsequent clarification and stabilization treatments, as well as the duration of storage (Bartkovsky et al., 2020) form the specific profile of white wines, with a pronounced varietal character.

Wine contains a large number of components of various origin and in different concentrations. Some of them pass from the grapes, while others are formed during the alcoholic fermentation and aging (Muñoz-Castells et al., 2023). White wines are characterized by a higher content of volatile aromatic compounds, organic acids and less phenolic substances. Over 40 organic acids have been identified in white wines, in free and bound states and of different origins. The predominating ones originate from the grapes (tartaric, malic, citric acid), while others, found in lower concentrations, are formed during the alcoholic fermentation (Rajkovic et al., 2007; Slegers et al., 2017). Total phenolic compounds in white wines range from 50 to 350 mg/l, with non-flavonoid phenols being predominant (Perez-Navaro et al., 2020; Jakabova et al., 2021). They have a key importance for the organoleptic properties in terms of colour, bitterness and astringency characteristics and stability (Chobanova, 2012).

The presence of aromatic components of different types and concentrations is of particular significance for the characteristics of wines from Muscat varieties. They originate from the grapes or are formed during the alcoholic fermentation and storage and belong to different groups – esters, aldehydes, higher alcohols, terpenes, norisoprinoids, fatty acids, etc. The application of different oenological practices, as well as the conditions of fermentation, lead to the synthesis of a large number of new compounds and significant changes in the aromatic profile of wines. Their content in different quantities might have a positive or negative effect on the wine aroma (Slegers et al., 2017; Marcon et al., 2019; Perez-Navarro et al., 2020).

White wines have specific organoleptic properties determined by their chemical composition. The prominence of the typical varietal aroma, with fruity notes and harmony in the taste components, is especially appreciated.

The objective of the study was to investigate the technological characteristics of the white wine varieties Tamyanka, Slava and Druzhba, grown under the soil and climatic conditions of Kyustendil region, Bulgaria.

MATERIALS and METHODS

The study was carried out in an experimental vineyard of the Institute of Agriculture – Kyustendil, Bulgaria, during the period 2021-2024. The terrain was located in the eastern part of the Kyustendil Valley at an altitude of 450 m. The experimental plot was planted on a highly leached, moderately sandy-clayey, slightly to moderate stony cinnamon forest soil (*Chromic Luvisols*) with a neutral response.

The object of the study was white wine varieties Tamyanka, Slava and Druzhba.

Tamyanka (Figure 1) is an old local wine variety, typical of the Balkan Peninsula. In Bulgaria, it is grown on small areas. The variety is medium ripening and its grapes ripen in mid-September. The vines are medium growing, with good fertility. The Tamyanka variety is susceptible to low winter temperatures and it is not resistant to downy and powdery mildew and grey rot. It grows best on humus, carbonate soils. The grapes accumulate enough sugars (20-26%), with good acidity for making of quality white wines with a golden-yellow colour, a specific Muscat aroma and a fine, harmonious taste. The variety is suitable for the production of dry, semi-dry and dessert wines (Radulov et al., 2004; Roychev, 2012).

The Slava (Figure 2) variety was selected through interspecific hybridization (Dunavska Gamza x Tsvetochniy) at the IVE – Pleven. It is sparsely distributed and mainly grown in ampelographic collections. Slava is an early ripening wine variety and its grapes ripen in the first half of September. The vines have moderate growth, good fertility and yield. It has increased resistance to downy and powdery mildew, grey rot and good frost resistance. The technological maturity of the grapes for the production of dry wines occurs at a sugar content of 20,4% and titratable acids of 7,4 g/l. The wines of the Slava variety have a straw-yellow colour with a greenish tint. Their aroma is fruity – Muscat-like, and the taste is dense, balanced and fresh (Roychev, 2012).

The Druzhba (Figure 3) variety (Misket Kaylashki x Hybrid II-51/23) was selected at the IVE – Pleven, as a result of complex interspecific hybridization and is grown on small areas in the region. The variety is early ripening and its grapes ripen at the end of August. The vines are intensively growing with high fertility. It is resistant to downy mildew, grey rot and low winter temperatures, but susceptible to powdery mildew. It grows best on light and fertile soils. The variety has a dual economic application – as table grapes for fresh consumption and for winemaking. Upon technological maturity, the sugar ratio varied from 19 to 21%, with titratable acids from 6,5 to 7,5 g/l. The resulting dry wines have a straw-yellow colour and a pleasant, well-expressed fruity – Muscat-like aroma. Their taste is soft, harmonious, with sufficient freshness (Roychev, 2012).

Figure 1. Tamyanka variety.

Figure 2. Slava variety.

Figure 3. Druzhba variety.

The vines from the studied varieties were planted in the spring of 2015, grafted on Berlandieri x Riparia SO4 rootstock and on stem Guyot training system. The planting distances were 2,50 m between the rows and 1,30 m inside the row. The rows faced east-west direction, taking into account the prevailing southwest and west winds in the area. The loading was 18 winter eyes per vine (3 x 2 + 1 x 12). Each variant was set in three repetitions with 10 vines equal in their vegetative development.

Annually after harvest, grapes from the studied white wine varieties was delivered for processing and vinification in the Experimental Winery of the Institute of Viticulture and Enology (IVE) – Pleven. The classical technology for white wine making was applied under the conditions of micro-vinification (Yankov, 1992): white grapes → crushing → sulfitation (50 mg/l SO_2) → straining off → pressing → must clarification → alcoholic fermentation → decanting → further sulfitation → storage.

Due to the compromise of the harvest by downy mildew (*Plasmopara viticola*) on the Tamyanka (*Vitis Vinifera*) variety, no grape picking and vinification were carried out in 2023.

The alcoholic fermentation was carried out by pure culture dry wine yeast *Saccharomyces cerevisiae* at a dose of 10 g/hl and temperature 20°C. Upon the process completion, the wines were decanted and further sulfited.

The chemical composition of the grapes and the obtained wines were analysed in the Laboratory of Wine Technology, IVE – Pleven. Methods generally accepted in winemaking practice were applied to determine the main indicators (Ivanov et al., 1979; Chobanova, 2007):

- sugars, % – hydrometer of Dujardin
- glucose, g/l – iodometric method
- fructose, g/l – calculation method
- glucoacidimetric index (GAI) – calculation method as the ratio of sugars (%) and TA (g/l).
- alcohol, vol. % - distillation method, Gibertini apparatus with densitometry of the distillate density;
- sugars, g/l – Schoorl's method;
- total extract (TE), g/l - Gibertini apparatus with densitometry;
- sugar-free extract (SFE), g/l – calculation method (the difference between TE and sugars);
- titratable acids (TA), g/l – titration with NaOH with bromothymol blue indicator
- tartaric and malic acid, g/l – Pochinok's method
- volatile acids, g/l – distillation method with titration with NaOH with phenolphthalein indicator
- pH – pH-meter

- total phenolic compounds (TPC), g/l gallic acid - Singleton et Rossi method with Folin–Chiocalteu reagent
- colour intensity I, [abs. units] – method of Somers.

The wines organoleptic properties were assessed by a tasting panel of specialists of the IVE – Pleven according to 100-score scale for the indicators colour, aroma, taste and general impressions (Tsvetanov, 2001).

The statistical processing of the results was done using the standard deviation (±SD) method, using Excel 2007 from the Microsoft Office software.

RESULTS and DISCUSSION

During the study, the main weather elements in the Kyustendil region, relevant to the development of vines, were measured annually. The absolute minimum air temperature during the complete dormancy of plants, in two of the years, dropped down to critical values for the regenerative organs (-18,0ºC). The average starting date of stable retention of air temperature above 10°C was April 11, which was 2 days later than the multi-year norm (Table 1).

Table 1. Agroclimatic parameters for the period 2021-2024.

Kyustendil, year	tº > 10ºC		Duration of the period in days		Total temperature sum, t°>10ºC	Average air temperature for July, ºC	Average air temperature for August ,ºC	Hydrothermal coefficient (HTC) for VI - VIII months)	Precipitation in June, July and August	Absolute minimum air temperature (average), ºC
	Average start date	Average end date	t°> от 10ºC	Frost-free						
1956-2020*	08/IV	23/X	198	192	3391	20,9	21,1	0,77	146,0	-16,7
2021	25/IV	23/X	182	179	3153	21,2	22,2	0,38	72,9	-18,0
2022	21/IV	28/X	187	186	3197	21,5	19,0	1,23	228,8	-18,0
2023	11/IV	07/XI	208	206	3827	24,0	23,2	1,60	324,5	-13,0
2024	27/III	21/X	209	208	3943	25,0	23,9	0,61	135,6	-13,0
Average	11/IV	29/X	197	195	3530	22,9	22,1	0,96	190,5	-15,5

*Perennial norm for the Kyustendil region

Warm winters in recent years had caused earlier and earlier plants' development in the major vine-growing regions of Bulgaria, as a result of which the danger of spring frosts increased. In the Kyustendil region, the smallest temperatures raise was found in the period February – April. The retention of vine growth was well expressed, especially in the last 5 years, and hence the less probability of damage from late spring frosts. The average, multi-year date of the last spring frost in Kyustendil was

April 8th. According to this criterion, in 82,0% of cases the danger of late spring frosts in the region had passed. The average daily air temperature reached values of +10ºC in autumn on October 29th. The duration of the period between these two dates was 197 days with a total temperature sum of 3530°C. The results for the average monthly temperature in July, which was vital for the grape technological qualities, showed that for the study period it was 22,9ºC. The obtained numerical value was by 2ºC higher than the average for the period 1956 – 2020. The last two years of the study (2023 and 2024) had been the warmest since meteorological recordings had been performed in the Kyustendil region (1904). In 2024, 46 days with absolute maximum air temperatures between 35,1 – 40,0ºC and 6 days with over 40,0ºC were registered. For comparison, the average values of these indicators for the period 1904 – 2020 were 6 and 0,3 days, respectively. The hydrothermal coefficient (HTC) reflecting heat and moisture provision for June, July and August was 0,96 on the average, which characterized the period as well wetted (Table 1).

The established rates of the individual climate elements are a prerequisite for the effective growing of early and mid-early grape varieties.

Grapes have a diverse chemical composition, which varied depending on the variety, environmental conditions and other factors. Grape must of white varieties is a slightly coloured, yellow-green liquid. It contains numerous compounds from various groups, the majority of which are synthesized primarily during the ripening period. Sugars are the main component of the must and, together with the amount of titratable acids, are the key criterion for determining the wine and must quality. Sugar accumulation occurs at different rates during the maturing period, depending on the varietal specifics and the weather conditions that may accelerate or slow down the process. That also affects the grapes' acid profile (Yankov, 1992; Soyer et al., 2003; Shahood et al., 2020; Jakabova et al., 2021).

The results of the research carried out during the period 2021 – 2024 on the composition and characteristics of grapes and wine from the studied white varieties grown in the Kyustendil region are presented in Table 2 and Table 3.

The data in Table 2 showed that the sugar accumulation in the grapes from the studied varieties changed in different years depending on the relevant meteorological conditions. During the research period, the earliest harvest was carried out for the Tamyanka variety, in which the sugars ranged from 181,00 (2022) to 212,00 (2024) g/l, with the average content reported for the variety being 197,00±15,52 g/l. The rest varieties reached later their technological maturity in the Kyustendil region. For the Slava variety, the sugar ratio was on the average 194,50±6,45 g/l, varying from 185,00 (2024) to 199,00 (2021) g/l. For the Druzhba variety, the sugar content ranged from 156,00 (2021) to 187,00 (2024) g/l, with an average value of 174,00±15,12 g/l. The results pointed out that 2024 was the most favourable for the

Tamyanka and Druzhba varieties in terms of sugar accumulation. For the period 2021 – 2024, in the researched growing area, the lowest sugars were recorded in the Druzhba variety.

In the grape must of the studied varieties, the ratio between the analysed monosaccharides glucose and fructose was lower than 1, with fructose being quantitatively predominant. That trend was observed in grapes from the four harvests. A higher concentration of glucose and fructose was recorded in the samples of the Tamyanka and Slava varieties, respectively 81,93±15,31 g/l, 115,07±12,63 g/l and 83,58±7,31 g/l, 110,93±11,04 g/l. The Druzhba variety had the lowest ratio of monosaccharides (71,20±12,21 g/l and 102,80±5,53 g/l), consistent with the lower sugar accumulation. The highest glucose content was found in the sample of Tamyanka (2024), and fructose – in Tamyanka and Slava (2021).

Table 2. Chemical composition of grapes from the studied white varieties for the period 2021 – 2024.

Indicators / **Vintage**	**Date of harvest**	**Sugars, g/l**	**Glucose, g/l**	**Fructose, g/l**	**Titratable acids, g/l**	**Ttartaric acid, g/l**	**Malic acid, g/l**	**GAI**	**pH**
Tamyanka									
2021	16/09/	198,00	69,40	128,60	7,43	4,31	3,25	2,66	3,09
2022	08/09/	181,00	77,40	103,60	7,50	3,49	5,16	2,41	3,39
2024	09/09/	212,00	99,00	113,00	7,58	3,60	4,39	2,80	3,29
±SD		*197,00 ±15,52*	*81,93 ±15,31*	*115,07 ±12,63*	*7,50 ±0,08*	*3,80 ±0,45*	*4,27 ±0,96*	*2,62 ±0,20*	*3,26 ±0,15*
Slava									
2021	28/09/	199,00	72,90	126,10	6,94	4,36	3,82	2,87	3,16
2022	21/09/	198,00	87,30	110,70	6,45	3,06	5,39	3,07	3,43
2023	20/09/	196,00	89,10	106,90	6,60	2,29	4,50	2,97	3,18
2024	18/09/	185,00	85,00	100,00	6,45	3,62	3,56	2,87	3,34
±SD		*194,50 ±6,45*	*83,58 ±7,31*	*110,93 ±11,04*	*6,61 ±0,23*	*3,33 ±0,88*	*4,32 ±0,82*	*2,95 ±0,10*	*3,28 ±0,13*
Druzhba									
2021	05/10/	156,00	59,40	96,60	6,51	4,04	3,42	2,40	3,27
2022	08/09/	167,00	63,20	103,80	6,88	3,16	5,70	2,43	3,43
2023	20/09/	186,00	76,20	109,80	5,03	2,45	3,80	3,70	3,30
2024	09/09/	187,00	86,00	101,00	5,63	2,80	3,15	3,32	3,35
±SD		*174,00 ±15,12*	*71,20 ±12,21*	*102,80 ±5,53*	*6,01 ±0,84*	*3,11 ±0,68*	*4,02 ±1,15*	*2,96 ±0,65*	*3,34 ±0,07*

The results of the grape must analysis (Table 2) showed that despite the higher sugars ratio, the highest titratable acids were recorded in the Tamyanka variety, varying from 7,43 (2021) to 7,58 (2024) g/l (average 7,50±0,08 g/l). A probable reason might be the variety specifics, manifested when grown in the Kyustendil region, as well as the climatic conditions and drought during the grape ripening period. The lowest titratable acidity was found in the Druzhba variety – from 5,03 (2023) to 6,88 (2022) g/l (average 6,01±0,84 g/l). The quantity of the main organic acids (tartaric and malic) was also determined in the must of the studied varieties. Except of the 2021 harvest, in the rest three years (2022 – 2024) malic acid was quantitatively predominant in all three studied varieties (Table 2). For the period, the highest tartaric acid content was found in the grapes from the 2021 harvest (from 4,04 to 4,36 g/l), and malic acid – in the 2022 harvest (from 5,16 to 5,70 g/l).

In the Slava and Druzhba varieties, the glucoacidimetric indicator (GAI) had similar rates – on the average 2,95±0,10 and 2,96±0,65, respectively. In the Tamyanka variety, on the average for the period, it was 2,62±0,20. From the samples of the Tamyanka variety the 2024 harvest had the highest GAI, from the Slava variety it was the 2022 harvest, and from the Druzhba variety – the 2023 harvest.

The values of the pH indicator in the grape must of the studied varieties and harvests were within the typical range for white wine varieties.

The chemical composition of white wines, in addition to the varietal specifics, also depends on the proper conduct of the technological process. The full course of the alcoholic fermentation ensures the production of wines with optimal alcohol and sugar content. The application of various oenological practices changes the extractivity of the wine, its phenolic and aromatic profile. These indicators have the greatest influence on the wines' organoleptic properties. The sugar-free extract, which is a set of all non-volatile components, titratable acids and the phenolic content varied widely, depending on the variety, the growing region and the vinification method. The values of these indicators determine the freshness and density of the wines' taste, their balance and harmony (Stoica et al., 2015; Bora et al., 2016; Slegers et al., 2017; Bayram and Kayalar, 2018).

The results of the studied white wines' chemical analysis, for the period 2021 – 2024, are presented in Table 3. The alcohol content of the samples was consistent with the sugar accumulation in the grapes of the studied varieties and harvests. The highest average alcohol concentration had the Tamyanka wines (11,91±0,73 vol. %), followed by Slava (11,60±0,19 vol. %), and the lowest was in Druzhba (10,97±0,62 vol. %). For the Tamyanka and Druzhba varieties, the samples from the 2024 harvest had the highest alcohol and for Slava, it was the sample from the 2023 harvest.

Every year, the alcoholic fermentation in all wines proceeded normally and to the end. The average amount of the residual sugars was 1,81±1,39 g/l (Tamyanka), 2,20±0,86 g/l (Slava) and 1,29±0,74 g/l (Druzhba), which defined them as "dry".

The amount of the total and sugar-free extract of the samples varied per harvest, with the highest content being recorded in wines from the Tamyanka variety, on the average 22,13±2,68 g/l and 20,32±1,68 g/l, respectively. The sugar-free extract comprised the non-volatile components such as phenols, nitrogen and mineral substances, which determined and formed the taste density. The change in this indicator decreased per varieties in the order Tamyanka (20,32±1,68 g/l) > Druzhba (18,56±1,34 g/l) > Slava (17,58±0,71 g/l). In the Tamyanka and Druzhba wines, the samples from the 2024 harvest had the highest extractivity, while Slava then had the lowest SFE, and the highest in the 2021 harvest (Table 3).

Table 3. Chemical composition of the experimental white wines from the studied varieties for the period 2021 - 2024.

Indicators / **Vintage**	**Relative density**	**Alcohol, vol %**	**Sugars, g/l**	**Total extract, g/l**	**Free-sugar extract, g/l**	**Titratable acids, g/l**	**Volatile acids, g/l**	**Tartaric acid, g/l**	**Malic acid, g/l**	**Total phenolic compounds, g/l**	**Colour intensity I, [abs. units]**	**pH**	**Tasting evaluation**
Tamyanka													
2021	0,9932	11,18	1,64	20,20	18,56	7,08	0,60	2,81	2,18	0,55	0,49	3,34	78,75
2022	0,9913	11,90	0,52	21,00	20,48	7,08	0,48	2,11	4,89	0,42	0,42	3,28	79,13
2024	0,9932	12,65	3,28	25,20	21,92	7,08	0,50	3,45	3,85	0,52	0,52	3,22	78,50
±SD	*0,9926 ±0,01*	*11,91 ±0,73*	*1,81 ±1,39*	*22,13 ±2,68*	*20,32 ±1,68*	*7,08 ±0,00*	*0,53 ±0,06*	*2,79 ±0,67*	*3,64 ±1,37*	*0,50 ±0,07*	*0,48 ±0,05*	*3,28 ±0,06*	*78,79 ±0,32*
Slava													
2021	0,9927	11,54	1,80	20,10	18,30	6,70	0,54	2,42	3,38	0,30	0,31	3,22	80,37
2022	0,9929	11,68	1,54	19,60	18,06	6,22	0,66	2,75	3,84	0,42	0,40	3,30	78,40
2023	0,9935	11,82	1,98	19,10	17,12	6,40	0,60	2,62	3,82	0,49	0,38	3,32	76,50
2024	0,9925	11,37	3,46	20,30	16,84	6,10	0,48	2,45	3,45	0,58	0,43	3,39	76,78
±SD	*0,9929 ±0,01*	*11,60 ±0,19*	*2,20 ±0,86*	*19,78 ±0,54*	*17,58 ±0,71*	*6,36 ±0,26*	*0,57 ±0,08*	*2,56 ±0,15*	*3,62 ±0,24*	*0,47 ±0,16*	*0,38 ±0,05*	*3,31 ±0,07*	*78,01 ±1,78*
Druzhba													
2021	0,9915	10,44	0,90	18,80	17,90	6,23	0,36	2,96	3,18	0,27	0,34	3,31	80,00
2022	0,9910	10,43	1,32	20,00	18,68	5,73	0,42	2,10	3,85	0,55	0,45	3,24	79,50
2023	0,9930	11,50	2,32	19,60	17,28	5,00	0,66	1,34	3,79	0,51	0,40	3,38	74,50
2024	0,9932	11,52	0,62	21,00	20,38	5,00	0,50	2,66	3,52	0,42	0,54	3,36	73,11
±SD	*0,9922 ±0,01*	*10,97 ±0,62*	*1,29 ±0,74*	*19,85 ±0,91*	*18,56 ±1,34*	*5,49 ±0,60*	*0,49 ±0,13*	*2,27 ±0,71*	*3,59 ±0,30*	*0,44 ±0,12*	*0,43 ±0,08*	*3,32 ±0,06*	*76,78 ±3,48*

The titratable acidity of the wines varied widely depending on the varietal characteristics and changed in the order Druzhba (5,49±0,60 g/l) < Slava (6,36±0,26 g/l) < Tamyanka (7,08±0,00 g/l). The results showed that despite the higher sugars, higher titratable acidity (7,08 g/l) was retained in the Tamyanka grapes and in the resulting wines. For the remaining two varieties Slava and Druzhba, the samples from the 2021 harvest had the highest acidity - 6,70 g/l and 6,23 g/l, respectively.

Of the analysed organic acids (tartaric and malic), a quantitative predominance of malic acid was observed in all studied white wines. The rates of the volatile acids and the pH indicator in all samples were within normal limits for young white wines.

The white wines of the studied varieties had a similar content of phenolic compounds. The change in TPC increased in the order Druzhba (0,44±0,12 g/l) < Slava (0,47±0,16 g/l) < Tamyanka (0,50±0,07 g/l). No similarity was found for the highest and the lowest phenolic concentration per varieties and harvests. In the 2021 harvest, the highest phenolic concentration was recorded in the Tamyanka wine (0,55 g/l), while in the other two varieties the lowest – 0,30 g/l (Slava) and 0,27 g/l (Druzhba). Of the Slava wines, the sample from the 2024 harvest contained the most phenols (0,58 g/l), and from Druzhba – this was the sample from the 2022 harvest (0,55 g/l).

The colour intensity of the obtained experimental wines per varieties and vintages varied within a normal range for white wines – from 0,38±0,05 (Slava) to 0,48±0,05 (Tamyanka) abs. units.

The results of the organoleptic analysis of the experimental samples showed that for the studied vintages, the wines with the highest tasting scores were from the Tamyanka variety (average 78,79±0,32 points), followed by Slava (average 78,01±1,78 points), and the lowest rated were those from the Druzhba variety (average 76,78±3,48 points). The Tamyanka and Slava samples contained more titratable acids, therefore they were preferred and determined as fresher during the tasting. For the Slava and Druzhba varieties, the highest scores were received for the samples from the 2021 harvest, in which the highest titratable acidity was recorded.

For the Tamyanka variety, the wine from the 2022 vintage got the most points – 79,13 (Table 3). The studied white wines had organoleptic characteristics corresponding to the varietal specifics and no technological deviations were identified. All had a typical varietal aroma, more or less pronounced in the different years, sufficient density, freshness and harmony in taste.

CONCLUSION

Based on the results obtained from the study of the Tamyanka, Slava and Druzhba varieties in the Kyustendil region, it could be summarized:

- The sugar content in the grapes of the studied varieties depended on the varietal specifics and the weather conditions of the year. During the period 2021 – 2024, the Tamyanka variety was harvested the earliest, while the other varieties reached technological maturity later and showed lower sugar accumulation. The lowest sugars and titratable acidity were determined in the Druzhba variety. The highest titratable acids were analyzed in the Tamyanka grapes.

- The experimental white wines had a chemical composition without deviations from the norms of the studied indicators. The alcohol content of the white wines corresponded to the sugar accumulation in the grapes per varieties and harvests. Their titratable acidity varied widely depending on the varietal specifics and changed in the order Druzhba < Slava < Tamyanka. The wine with the highest extract content (SFE) and titratable acidity was the wine of the Tamyanka variety. In the samples, the amount of TPC was close to the average for the period, increasing in the order Druzhba < Slava < Tamyanka.
- The sensory characteristics of the studied white wines corresponded to the varietal specifics – typical aroma, sufficient density, freshness and harmony in taste. In the organoleptic analysis, the wines with the highest tasting scores were those of the Tamyanka variety, followed by Slava, and the wines of the Druzhba variety were the lowest rated.

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Author Contributions

In this study, the contribution of the authors was equal; both authors contributed equally to the development of the research idea, data analysis, writing and proofreading stages.

Responsible Artificial Intelligence Statement

No artificial intelligence support was received in any part of this study.

Conflicts of Interest

The authors declare that there are no conflicts of interest related to the publication of this study.

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