



Technological characteristics of the white wine grape variety Kristalen

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Abstract. During the period 2020-2024, a study was conducted on the technological characteristics of the white wine grape variety Kristalen. The research was carried out at the Institute of Agriculture and Seed Science "Obraztsov Chiflik" – Rousse and the Institute of Viticulture and Enology – Pleven and covered 5 consecutive harvests. The changes in the climatic factors in the growing region were monitored each year as well as their influence on grape quality. The grapes were processed using the classical technology for white wine production under microvinification conditions. The chemical composition of the grapes was determined for each vintage as well as that of the experimental wines made. The grapes from the 2024 harvest had the best indicators, which showed the highest sugar accumulation, titratable acids content and glucoacidimetric indicator. The 2023 harvest had the lowest values of the studied components. No general trend was established regarding the analysed chemical indicators in the composition of the experimental white wines. The highest alcohol content was found in the 2021 vintage, while the highest levels of residual sugars and phenols were determined in 2023, of total and sugar-free extract - in 2024, and of titratable acids - in 2022. An organoleptic analysis was also performed of the experimental wines. The wine with the best sensory profile in terms of colour, aroma, and taste was the 2022 vintage, which was evaluated as the most harmonious and well-balanced.

Keywords: Kristalen variety, grapes, white wine, chemical composition, sensory characteristics

Introduction

The grapevine has been one of the main crops cultivated by humans since ancient times. The species *Vitis vinifera* has been the most widespread in all wine-growing regions of the world. It is grown for the production of wine grapes, table grapes, raisins, juices and other products. A specific feature of *Vitis vinifera* is its high sensitivity to diseases and pests. Improving the adaptive potential of the species is achieved through the application of various grapevine breeding methods. Intraspecific and interspecific hybridization is one of the approaches to obtain hybrid varieties with increased resistance or tolerance to various abiotic and biotic stress factors, higher yields and better product quality. This method is one of the opportunities for developing new varieties adapted to changing climatic conditions (Haygarov et al., 2008; Ivanov et al., 2014; Pedastsaar et al., 2014; Teissedre, 2018; Yoncheva et al., 2019; OIV, 2021; Töpfer and Trapp, 2022; Bayram et al., 2023).

The technological characteristics of the variety determine the production direction for the use of the raw material and include indicators such as the mechanical structure of the cluster and berry, the chemical composition of the grapes and the wine and the organoleptic properties of the resulting wines. The technological qualities of grapes and primarily their

composition in terms of basic chemical compounds depend on the genetic potential and the specifics of the variety, as well as on the application of various cultivation practices (Friedel et al., 2015).

The chemical composition of grapes is one of the key criteria for their quality. The predominant components are the content of sugars and titratable acids. During the ripening period, sugar accumulation follows a tendency to increase, which is associated with changes in the concentrations of glucose and fructose. Titratable acids, respectively, decrease proportionally, while the pH of the grape juice increases. The main organic acids are tartaric and malic acids, followed by citric acid. Their concentration has a determining role for the taste characteristics. The acid profile of grapes depends on a number of factors such as variety, degree of maturity, growing region, climatic conditions and others (Soyer et al., 2003; Abrasheva et al., 2008; Shahood et al., 2020).

The chemical composition of wines is complex and is determined by the variety, the cultivation methods, the agrotechnical practices, the technological procedures used during the grape processing and the vinification process (Badamtestseg et al., 2012; Yabaci Karaoğlu et al., 2015; Bora et al., 2016; Urcan et al., 2016). Wine contains a large number of components in various concentrations. Some of

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them are transferred directly from the grapes, while others are formed as a result of yeast metabolism during the alcohol fermentation or through various processes occurring during wine aging (Muñoz-Castells et al., 2023).

The composition of white wines differs significantly from that of red wines, due to the characteristics of the white varieties and the technology used for their production. White wines have a higher content of volatile aromatic compounds and organic acids and lower levels of phenolic substances. Both in grapes and in wine, the quantitatively predominant acids are tartaric and malic acids as they account for about 90% of all organic acids. Phenolic compounds originate from grapes and, upon extraction, are transferred into the grape must. In white wines, non-flavonoid phenolic compounds predominate – cinnamic acids and catechins (Perez-Navarro et al., 2020; Jakabova et al., 2021).

The components of the wine composition also affect its organoleptic characteristics. The content of residual sugars and glycerine are key ones for determining its viscosity and density. The type and concentration of volatile aromatic compounds define the specificity of the aroma. Organic acids determine its freshness, and phenols influence its taste qualities. Tartaric acid suppresses sweetness and provides freshness, malic acid gives a sharp taste, lactic acid – softness, and succinic acid – a slight bitterness. The fullness and body of the wine taste are related to the type and content of phenolic compounds. They are responsible for the sensation of bitterness and astringency. The different oenological practices also affect the wine tasting qualities. By using different enzymes and yeast strains, the aromatic profile could be modified. When maceration is applied to white wine varieties, the contact with the solid parts in the resulting wines enhances the grassy tones in the aroma and increases bitterness in the taste. During the barrel aging, the wines also acquire specific characteristics (Aleixandre-Tudo et al., 2015; Perez-Navarro et al., 2020; Han et al., 2022).

The objective of this study was to investigate the technological characteristics (chemical composition and tasting qualities) of grapes and wine from the white wine variety Kristalen.

Material and methods

Characteristics of the variety and growing conditions

The study of the composition and characteristics of the white wine variety Kristalen covered five consecutive harvests during the period 2020-2024. The variety was selected through hybridization of the Pamid Ruse 1 and Kailashki Misket varieties grown in the Institute of Agriculture and Seed Science (IASS) "Obraztsov Chiflik" – Rousse.

Kristalen is a typical wine variety. The cluster is medium-sized (196.5 g), conical, sometimes winged, moderately compact, with a short to medium-long stem (4-7 cm). The berry is medium-sized (2.73 g), oval and yellow-green in colour. Its texture is fleshy and juicy, and the taste is harmonious. At technological maturity, the grapes contain 19.26% sugars and 7.42 g/l titratable acids. The grapes do not crumble and have very good transportability (Figure 1).



Figure 1. Kristalen variety

The Kristalen variety develops and bears fruit well, grafted onto SO4 and Chasla X Berlandieri 41B rootstocks. With a medium-high Guyot training system and a planting distance of 2.50/1.20 m, the grape yield per hectare is over 15 t. The vines have the potential to produce even higher yields with Moser and Umbrella training systems and drip irrigation.

The variety has increased winter hardiness and is resistant to cryptogamic diseases within the limits of the European-Asian vine *Vitis vinifera* L. and requires limited treatment against downy mildew and powdery mildew, only in the conditions of very high humidity (soil and air) and a natural infectious background. In case of severe damage from extreme cold below -18 to -20°C, it exhibits good capacity to recover. The length of the vegetation period from budding to physiological maturity of the grapes is about 150 days. The technological maturity in the region of the town of Rousse occurs around September 5-7. The variety Kristalen is suitable for growing under all types of training systems in the regions of the country with favourable conditions for the development and fruiting of early and mid-ripening white wine grape varieties (Mincheva et al., 2015).

The Kristalen grape variety has a pronounced fruity aroma, pleasant freshness and is suitable for the production of high-quality white wines, full-bodied and with a good harmony between alcohol, sugars and titratable acids, as well as for the production of high-alcohol beverages.

The experimental plantation was grown in a medium-high trunk bilateral cordon system with a planting distances of 2.50 m/1.20 m.

Processing of the grapes

Every year during the ripening season, the dynamics of sugar accumulation in the grapes was monitored. Upon reaching optimal ripeness for the variety, the grapes were harvested.

The grapes, in an amount of about 100 kg, were delivered for vinification to the Experimental Winery of the Institute of Viticulture and Enology (IVE) – Pleven. It was processed according to the classical technology for dry white wine production in the conditions of micro-vinification (Abrasheva et al., 2008): white grapes → crushing → sulphiting (50 mg/l SO₂) → straining off → pressing → must clarification → adding pure culture dry wine yeast *Saccharomyces cerevisiae* (10 g/hl) → alcoholic fermentation → decanting → further sulphiting → storage. The alcoholic fermentation occurred at a temperature of 18-20°C, with daily control and monitoring the changes of the sugars/dry matter by hydrometer of Dujardin. After the process was completed, the young wines were decanted, further sulphited and treated with bentonite to achieve colloidal stability.

Laboratory analyses

The research laboratory work was carried out in the Laboratory of Winemaking Technology at the IVE – Pleven. The chemical composition of the grapes of the studied variety and the resulting white wines were analysed.

Grapes chemical composition

The chemical composition of the grapes was determined according the following indicators and methods (Ivanov et al., 1979):

- sugars, % - hydrometer of Dujardin
- glucose, g/l – iodometric method
- fructose, g/l – calculation method
- titratable acids (TA), g/l - titration with NaOH with bromothymol blau indicator
- tartaric acid and malic acid, g/l – Pochinok's method
- pH - pH-meter
- glucoacidimetric index (GAI) – calculation method as the ratio of sugars (%) and TA (g/l).

Wine chemical composition

The main indicators of the chemical composition of the wines were analysed using methods generally accepted in winemaking practice (Ivanov et al., 1979; Chobanova, 2007):

- alcohol, vol.% - distillation method, Gibertini apparatus with densitometry of the distillate density
- sugars, g/l – Schoorl method
- total extract (TE), g/l – Gibertini apparatus with densitometry of the sugar-free sample
- sugar-free extract (SFE), g/l – calculation method (the difference between TE and sugars)
- titratable acids, g/l - titration with NaOH with bromothymol blau indicator
- tartaric acid and malic acid, g/l – Pochinok's method
- volatile acids, g/l – distillation method with subsequent titration with NaOH using phenolphthalein indicator
- pH – pH-meter
- total phenolic compounds, g/l gallic acid - Singleton et Rossi method with the Folin–Chiocalteu reagent
- colour intensity I [abs. units] – Somers method.

Sensory analysis

Each year, the organoleptic analysis of the experimental wines was carried out by the tasting committee of the IVE – Pleven. A 100-point scale was used to evaluate the samples based on the indicators of colour, aroma, taste and overall impressions (Tsvetanov, 2001).

Statistical analyses – it was performed using the standard deviation method ($\pm$ SD), with Microsoft Office Excel 2007.

Results and discussion

The chemical composition of grapes is determined by the characteristics of the variety and the weather factors in the growing region, during the stage of its ripening. Depending on these conditions, the sugar accumulation may be accelerated or slowed down, and the ratio between glucose and fructose changed. The meteorological conditions also affect the acid profile of grapes. The amounts of tartaric and malic acids are predominant among the organic acids contained and their concentration is indicative of the degree of maturity (Soyer et al., 2003; Jakabova et al., 2021). Grapes are rich in phenolic compound, which are the third dominant component after carbohydrates and acids. The individual groups are unevenly distributed in various parts of the cluster. They are mainly located in the skins, seeds and the bunches. The phenolic content of grapes depends on the variety and determines the concentration of phenols in wine (Godevac et al., 2010; Perestrelo et al., 2012).

The chemical composition of the Kristalen variety varied over the studied 5-year period, due to the influence of the weather conditions of each year. The technological maturity of the variety was reached in the period from September 5 to September 15. During this period, the earliest grape harvest was carried out in 2024, while the latest harvest was in 2023.

After crushing and processing the grapes, the main indicators of the must composition were determined (Table 1).

The sugar content in the grape must of the Kristalen variety for the period 2020-2024 was 188.20 $\pm$ 11.01 g/l. The lowest sugar value was recorded in 2023 (174.00 g/l), and the highest – in 2024 (204.00 g/l). Sugar accumulation in grapes during the ripening stage was strongly influenced by the climatic conditions of the year in the growing region. The lowest amounts of precipitation were recorded in July of two consecutive years – 2020 and 2021, and in all years of the experimental period, for the months of July and August, the hydrothermal coefficient (HTC) was below 1, which was an indication that the vines were not sufficiently supplied with moisture (Table 2). This was also related to the average monthly temperatures for the same period, with an increase observed for July from 24.1°C in 2020 to 26.5°C in 2024. The same indicator varied from 23.9°C to 25.9°C in August for the period 2020-2024.

Table 1. Chemical composition of grape must of the Kristalen variety, for the period 2020-2024

Vintage	Date of harvest	Indicators							GAI
		Sugars, g/l	Glucose, g/l	Fructose, g/l	Titrateable acids, g/l	Tartaric acid, g/l	Malic acid, g/l	pH	
2020	11/09/	183.00	97.20	85.80	5.25	4.05	4.66	3.40	3.48
2021	08/09/	190.00	74.00	116.00	5.22	2.45	4.77	3.34	3.64
2022	13/09/	190.00	92.70	97.30	5.43	2.58	3.86	3.20	3.50
2023	15/09/	174.00	70.50	103.50	5.13	2.32	3.70	3.30	3.39
2024	05/09/	204.00	77.00	127.00	5.48	2.86	3.36	3.29	3.72
±SD		188.20	82.28	105.92	5.30	2.85	4.07	3.31	3.55
		±11.01	±11.90	±16.05	±0.15	±0.70	±0.62	±0.07	±0.13

Table 2. Values of the hydrothermal coefficient for the period 2020-2024

Year	April	May	June	July	August	September	October
2020	0.37	1.31	2.04	0.01	0.03	0.77	1.46
2021	1.59	1.41	2.02	0.01	0.38	0.09	4.30
2022	2.21	0.34	1.15	0.12	0.92	2.25	3.62
2023	2.21	0.90	1.37	0.30	0.28	0.08	0.04
2024	1.66	1.09	0.57	0.99	0.13	1.10	0.40

The variation of the grapes sugar accumulation by harvests followed the order 2023 (174.00 g/l)<2020(183.00 g/l)<2021, 2022(190.00 g/l)<2024(204.00 g/l). The content of the two main monosaccharides – glucose and fructose was also determined in the grape must. For the studied period, the amount of glucose in the grapes was 82.28±11.19 g/l, and of fructose – 105.92±16.05 g/l on average. In the 2021, 2023 and 2024 vintages, their ratio was less than 1 with a predominance of the fructose. In 2022, the two monosaccharides had almost equal concentrations, while in 2020, glucose predominated quantitatively. In these two harvests the highest glucose content was recorded - 97.20 g/l and 92.70 g/l, respectively. Fructose reached its highest concentration in grapes from the 2021 and 2024 harvests - 116.00 g/l and 127.00 g/l, respectively.

For the studied period, titrateable acids varied within a narrow range from 5.13 g/l to 5.48 g/l, with the average value of the indicator 5.30±0.15 g/l. The data presented in Table 1 showed that the lowest sugar and acid content was recorded in the grapes from the 2023 harvest, and the highest sugars and titrateable acids were determined in the must in 2024. Among the main organic acids analysed (tartaric and malic), a quantitative predominance of malic acid was found in all samples. The average values of these components for the period were 2.85±0.70 g/l (tartaric acid) and 4.07±0.62 g/l (malic acid). The highest tartaric acid content was recorded in grapes from the 2020 harvest (4.05 g/l), and the highest malic acid ratio was established in the 2021 harvest (4.77 g/l).

The pH value varied within the range from 3.20 (2022) to 3.40 (2020), with an average of 3.31±0.07 for the period. The calculated glucoacidimetric index (GAI) had an average value of 3.55±0.13 and varied in the range from 3.39 (2023) to 3.72 (2024). These values corresponded to the harvests in which

the grapes had the lowest (2023) and highest (2024) content of sugars and titrateable acids.

The chemical composition of wine is complex and is determined both by the grapes composition and by the applied oenological practices for processing and vinification. These could modify the type and concentration of different groups of chemical components, as well as its organoleptic profile.

Of particular importance for the production of wines with normal composition and characteristics is the proper and complete course of the alcoholic fermentation (Stoica et al., 2015; Perez-Navaro et al., 2020). An important indicator is their extract content, defined as the sum of non-volatile components and depends on the specifics of the variety, the growing region, and the vinification method (Bora et al., 2016). The titrateable acidity of white wines varies widely and is affected by factors such as the variety and the degree of maturity (Slegers et al., 2017). As a rule, the acidity of wines is lower than that of the must (Soyer et al., 2003). The type and concentration of phenolic compounds present in grape must and wine are variety specific. They undergo changes due to the course of a number of processes under the influence of pH, oxygen, temperature, and storage conditions. Total phenolic compounds in white wines range from 50 to 350 mg/l, with non-flavonoids being predominant. Among flavan-3-ols, these are (+) catechin and (-) epicatechin (Abrasheva et al., 2008; Bayram and Kayalar, 2018; Seabrook, 2019).

The chemical composition of the obtained white wines from the Kristalen variety was directly dependent on the grape composition. For the period 2020-2024, no deviations from the normal values of the studied indicators were found in the experimental samples (Table 3).

The alcohol concentration of the samples was

proportional to the sugar content in the grapes from the respective harvest. On average, wines from the Kristalen variety had an alcohol content of 12.22 ± 0.54 vol.%. The values were within the range from 11.50 (2023) to 12.97 vol.% (2021). The samples from the 2024 and 2021 harvests had higher alcohol levels.

The amount of residual sugars (2.00 ± 0.87 g/l) indicated that the alcoholic fermentation process had proceeded normally and completely. Their content varied from 1.23 (2020) to 2.99

g/l (2023), which classified the experimental wines as dry.

Extract is an important indicator of the composition of wines, affecting their taste qualities. For the studied period, the average value of the total extract content of the samples was 20.58 ± 0.77 g/l, and that of the sugar-free extract was 18.58 ± 1.00 g/l. TE varied from 19.60 to 21.50 g/l, while SFE varied within a wider range – from 17.50 to 20.10 g/l. The highest contents of both TE and SFE were found in the wine from the 2024 vintage.

Table 3. Chemical composition of experimental white wines from the Kristalen variety for the period 2020-2024

Vintage	2020	2021	2022	2023	2024	±SD
Indicators						
Relative density	0.9917	0.9906	0.9906	0.9936	0.9917	0.9916 ± 0.03
Alcohol, vol %	12.18	12.97	12.05	11.50	12.42	12.22 ± 0.54
Sugars, g/l	1.23	1.48	2.90	2.99	1.40	2.00 ± 0.87
Total extract (TE), g/l	20.20	19.60	20.40	21.20	21.50	20.58 ± 0.77
Sugar-free extract (SFE), g/l	18.97	18.12	17.50	18.21	20.10	18.58 ± 1.00
Titrateable acids, g/l	5.18	5.14	5.28	5.10	5.25	5.19 ± 0.07
Volatile acids, g/l	0.42	0.24	0.54	0.36	0.68	0.45 ± 0.17
Tartaric acid, g/l	1.15	1.75	1.60	1.52	2.23	1.65 ± 0.40
Malic acid, g/l	3.39	4.26	3.25	3.30	3.08	3.46 ± 0.46
Total phenolic compounds, g/l gallic acid	0.39	0.27	0.28	0.64	0.52	0.42 ± 0.16
Color intensity I [abs. units]	0.22	0.34	0.40	0.34	0.30	0.32 ± 0.07
pH	3.32	3.36	3.35	3.33	3.31	3.33 ± 0.02

As a result of ongoing physicochemical processes during vinification, a reduction in titrateable acids was observed in the wine compared to the grapes. The average titrateable acidity of Kristalen wines for the 5-year study period was 5.19 ± 0.07 g/l. There was no significant difference in acidity of the samples from the studied harvests. Their values varied within narrow limits from 5.10 (2023) to 5.28 (2022) g/l. Of the analysed organic acids, the decrease in the amount of tartaric acid was more significant. That was due to ongoing processes related to the formation of tartrates and their precipitation. The reduction in the amount of malic acid was less pronounced. Titrateable acids significantly influenced the taste characteristics of white wines, imparting them their typical freshness. All experimental samples had normal values of volatile acidity (0.45 ± 0.17 g/l) and pH (3.33 ± 0.02).

The amounts of total phenolic compounds determined in the experimental samples were within the normal range for white wines. Their average content was 0.42 ± 0.16 g/l, varying from 0.27 to 0.64 g/l. Their increase by harvest followed the order $2021 < 2022 < 2020 < 2024 < 2023$. The colour intensity of the samples was also measured, with values typical for white wines (0.32 ± 0.07 abs. units).

The tasting qualities of the wines are complex in nature. White wines have specific organoleptic characteristics, distinguished by varietal aromas, fruity notes and an elegant fresh taste (Perez-Navaro et al., 2020; Esteves et al., 2024). In a study on the influence of the contact with solid parts during the alcoholic fermentation on the sensory profile of Chenin blanc wines, Perez-Navaro et al. (2020) found citrus and mint aromas in the control, while in the experimental variants,

shades of yellow apple, stone and dried fruits, as well as vegetal tones predominated. They explained this by an increase in the concentration of higher alcohols and a decrease in terpene levels.

The content of the main indicators of the chemical composition of the wines determined their organoleptic profile. The ratings received by the experimental wines during the tasting are presented in Figure 2.

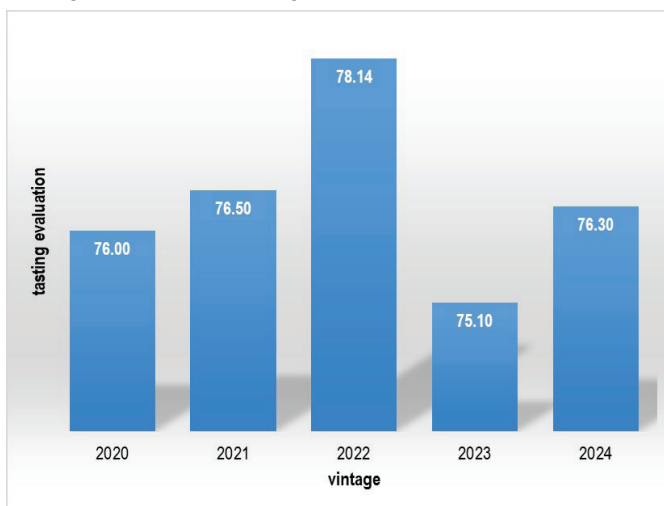


Figure 2. Tasting ratings of experimental white wines of the Kristalen variety for the period 2020-2024

The sample from vintage 2022 revealed the best characteristics and, accordingly, the highest score – 78.14 points. It was identified by the tasting committee as the best

in terms of colour, aroma and taste. Despite the lower content of alcohol, sugar-free extract and phenolic compounds, the wine was distinguished as the most well-balanced. The higher titratable acidity contributed to a pleasant freshness and harmony. The sample from the 2023 vintage (75.10 points) showed the weakest organoleptic characteristics, having the lowest levels of alcohol and titratable acids and the highest levels of residual sugars and phenolic substances. The wines from the other three vintages received similar tasting ratings and therefore there were no significant differences in their tasting qualities.

Conclusion

The results obtained from the study of the technological characteristics of the Kristalen variety showed that the chemical composition of grapes by harvest depended on the climatic conditions during the ripening stage. The grapes from the 2024 harvest had the best chemical composition - the highest sugar accumulation, titratable acid content and GAI. The 2023 harvest showed the lowest values of these parameters. No general trend was observed regarding the analyzed chemical indicators of the experimental white wines. The sample with the highest alcohol content was the 2021 harvest, of residual sugars and phenols - 2023, of total and sugar-free extract - 2024, of titratable acids - 2022. The wine with the best organoleptic profile in terms of color, aroma and taste was the 2022 harvest, determined as the most harmonious and balanced.

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