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Original article

Technological Characteristic of Cabernet Sauvignon Wine Produced from Organically Grown Grapes

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Abstract

The opportunities for organic growing of the Cabernet Sauvignon variety in the region of the town of Pleven, Central Northern Bulgaria, were studied during the period 2017-2020. Conventional and organic plant protection measures against the diseases downy mildew (*Plasmopara viticola*) and powdery mildew (*Oidium tuckeri*) were undertaken in the experimental plantations. In the organic cultivation of the variety, the products Funguran OH 50 WP and Thiovit Jet 80 WG were used, with seven treatments carried out annually. In the conventional cultivation, five or six combined treatments were applied. In the period of technological maturity, a minor attack of downy mildew and powdery mildew was found on the foliage and the clusters in both variants. The damage index from both diseases was higher in the organic production, but the differences found did not have a significant impact on the quality of the grape harvest. In the organic grape-growing, the amount of the input elemental Cu was strictly monitored. A technological characteristic of the Cabernet Sauvignon wines obtained from both growing variants was made. The difference in the main indicators of the grapes chemical composition was insignificant. The average rate of sugars, total acidity and glucoacidimetric index was similar. No significant differences were observed in the ratios of most indicators of the wines' chemical composition. The contents of alcohol, sugars, total acidity and extract in the samples of both variants were identical. More differences stood out relating the total phenolic compounds, anthocyanins and colour intensity, as their rates were higher in the conventional wines. Due to their better taste and color features, these samples had higher tasting scores and were superior in their organoleptic qualities compared to the organic wines.

Keywords: Cabernet Sauvignon, Organic Production, Grapes, Wine, Chemical Composition, Tasting Assessment.

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INTRODUCTION

The attractiveness of organic farming and its products in modern society has been constantly growing. The main goal has been the production of bio food, in which natural substances and processes were used. Organic agriculture has a limited impact on the environment, promotes the protection of natural resources and ecological balance, the maintenance of biological diversity, the improvement of soil fertility (Dimitrova et al., 2013; Kabakchieva, 2017; Ivanova, 2019; Regulation (EU) № 848/2018; https://ec.europa.eu/info/food-farming-fisheries/farming/organic-farming/organics-glance_bg; http://frenchscout.com/organic-wines).

The interest of grape growers and wine makers in the organic cultivation of vineyards has also growing strongly. The areas with organic cultivation of wine and table grape varieties have been increasing. The consumer demand and marketing for these products have been expanding, due to the increased desire of the population for a healthy lifestyle (Vachevska et al., 2007; Dimitrova et al., 2013; Ivanova, 2019; Regulation (EU) № 848/2018).

Conventional and organic viticulture differed mainly in the applied agricultural practices such as fertilization, maintenance of the soil surface and plant protection. Organic viticulture had been based on methods and practices excluding the use of chemical agents (fertilizers, pesticides, growth regulators) and genetically modified organisms. The diseases and enemies control was carried out through the complex application of a set of measures, such as the selection of suitable varieties and locations for the vineyards, appropriate pruning and the controlled use of authorized fungicides containing sulfur and copper (Parlevliet and McCoy, 2001; Vachevska et al., 2007; Kostadinova and Popov, 2015; Kabakchieva, 2017; Ostroukhova et al., 2021; Regulation (EU) № 848/2018; http://savagevines.co.uk/the-health-benefits-of-organic-wine).

In wine making, according to the principles of organic farming, requirements were set for the method of grape harvesting, the equipment for grapes processing, the vats for vinification and wine storage, minimizing the physical treatments, strongly reducing the use of sulfur dioxide SO_2 (Parlevliet and McCoy, 2001; Abrasheva et al., 2008; Regulation (EU) № 889/2008; Regulation (EU) № 848/2018; http://frenchscout.com/organic-wines; http://savagevines.co.uk/the-health-benefits-of-organic-wine). The maximum sulphite ratio in organic wines had been lower than that allowed for non-organic wines. This indicator had been strictly monitored and limited by the national and international wine legislation (Regulation (EU) № 889/2008). In case of extreme weather conditions in a given year, creating prerequisite for the deterioration of the organic harvest quality in a certain area, it was permissible the introducing of higher doses of SO_2 by the grower.

The use of different practices in the cultivation of the vines in an organic and conventional way had determined some differences in the quality and composition of the obtained grapes and wine.

A significantly higher accumulation of sugars, phenolic components and anthocyanins was found in the organically grown grapes compared to the conventional ones. The organic wines had higher ratio of ethanol, phenols, anthocyanins, pyruvic and α-ketoglutaric acid and lower rate of aldehydes (Ostroukhova et al., 2021).

The organic harvest quality strongly depended on the climatic conditions during the year, the characteristics of the cultivation area and the processing technology used. In unfavorable years, when the vines had been exposed to abiotic and biotic stress, the yield was reduced, but the grapes accumulated more sugars and resveratrol, useful for the human body, and more polyphenols with antioxidant properties were formed (Artem et al., 2021; Hasanaliyeva et al., 2021).

The phenolic components amount and the antioxidant activity had been important for the characteristics of red wines and depended on the variety and the production technology. With longer maceration during vinification, the resulting wines had higher ratio of pigments and polyphenols (Artem et al., 2021). A number of comparative studies had been carried out on their content in the organic and conventional produce. The amount of phenolic compounds and the antioxidant activity of grapes and wine of the Monastrell variety were similar, with insignificantly higher rate in the organic sample (Mulero et al., 2010, Mulero et al., 2011). Hasanaliyeva et al. (2021) also observed little differences in the phenolic and anthocyanin profile of the organic and conventional grapes, but determined a higher antioxidant activity in the organic production. The vinification scheme applied (classical maceration, addition of enological enzymes and prolonged maceration) did not either significantly affect the amount of phenols and the antioxidant activity of the organic wines of the Monastrell variety (Mulero et al., 2011).

Other studies indicated higher content of anthocyanins in the conventional products and almost insignificant differences in terms of phenolic acids, flavanols and flavonols, trans-resveratrol, antioxidant activity and the mineral elements Cu, Fe and Mn (Dutra et al., 2018). In organic and conventional wines from the Canary Islands, 49 elements of their mineral composition were identified, with less toxic elements found in the organic products (Gonzalez et al., 2021).

The organic and conventional vine-growing also affected the aromatic composition and the organoleptic profile of the produce. Lorenzo et al. (2015) found higher ratio of higher alcohols and lower of esters and higher fatty acids in the organic variant. That predetermined the differences in the aroma of the wines, with more intense floral nuances standing out in the organic sample, and more prominent fruit notes in the conventional sample.

In organic viticulture, it had been of particular importance to choose a suitable variety according to the terroir conditions in the area of cultivation, taking into account the demand on the local and international market for the realization of the production. Therefore, in most organic farms, established traditional varieties such as Cabernet Sauvignon and Chardonnay had been most often grown (Vachevska et al., 2007).

The objective of this study was to investigate the opportunities of producing Cabernet Sauvignon wine obtained from organically grown grapes in the region of Pleven, Central Northern Bulgaria, by comparing the qualitative and quantitative indicators of the harvest from organic and conventional growing.

MATERIALS and METHODS

Plantation, plant protection and agrotechnics

The study was carried out during the period 2017-2020 at the Institute of Viticulture and Enology (IVE) – Pleven, Central Northern Bulgaria. The object of the study were wines of the Cabernet Sauvignon variety, from four consecutive harvests obtained from grapes grown organically and conventionally. The experimental vineyards were located in the Experimental Base of IVE – Pleven on an area of two plots of the same size (0.5 ha). The inter-row distance was 3.20 m, the intra-row distance - 1.20 m, and the stem height was 1.00 m. The soil type was slightly leached black soil formed on clay loess. The change of the main climatic indicators (precipitation rate and air temperature) was reported by the meteorological station Metos Weather data 000003 CA, located on the territory of the Experimental Base.

The field trial was set in two variants: Variant 1 – organic grape growing; Variant 2 – conventional grape growing

Table 1a. Combined treatments for downy mildew and powdery mildew control in the conventional cultivation of the Cabernet Sauvignon variety during the period 2017-2020.

Year	Treatment №	Applied fungicides and doses
2017	1	Verita WG (2.0 кg/ha) + Systane Super 24 EC (10 ml/ha)
	2	Verita WG (2.0 кg/ha) + Topas 100 EC (150 ml/ha)
	3	Ridomil Gold MC 68 WG (3.0 кg/ha) + Top Plus 70 WP (1.0 кg/ha)
	4	Ridomil Gold MC 68 WG (2.5 кg/ha) + Kumulus DF (3.0 кg/ha)
	5	Triomax 45 WP (2.5 кg/ha) + Topas 100 EC (150 ml/ha)
2018	1	Ridomil Gold MC 68 WG (2.5 кg/ha) + Topas 100 EC (150 ml/ha)
	2	Funguran OH 50 WP (1.5 кg/ha) + Topas 100 EC (150 ml/ha)
	3	Ridomil Gold MC 68 WG (2.5 кg/ha) + Topas 100 EC (150 ml/ha)
	4	Triomax 45 WP (2.0 кg/ha) + Thiovit Jet 80 WG (2.5 кg/ha)
	5	Ridomil Gold MC 68 WG (2.5 кg/ha) + Topas 100 EC (150 ml/ha)
	6	Acrobat Plus WG (2.0 kg/ha) + Bayfidan 250 EC (0.1 l/ha)
2019	1	Topas 100 EC (150 ml/ha)
	2	Ridomil Gold MC 68 WG (2.5 кg/ha) + Bayfidan 250 EC (0.1 l/ha)
	3	Triomax 45 WP (2.0 кg/ha) + Bayfidan 250 EC (0.1 l/ha)
	4	Triomax 45 WP (2.0 кg/ha) + Bayfidan 250 EC (0.1 l/ha)
	5	Ridomil Gold MC 68 WG (2.5 кg/ha) + Topas 100 EC (150 ml/ha)
	6	Triomax 45 WP (2.0 кg/ha) + Bayfidan 250 EC (0.1 l/ha)
2020	1	Ridomil Gold MC 68 WG (2.5 кg/ha) + Topas 100 EC (150 ml/ha)
	2	Ridomil Gold MC 68 WG (2.5 кg/ha) + Spirox (60 ml/ha)
	3	Ridomil Gold MC 68 WG (2.5 кg/ha) + Spirox (60 ml/ha)
	4	Triomax 45 WP (2.5 кg/ha) + Bayfidan 250 EC (0.1 l/ha)
	5	Cuproseyt Gold M (1.5 кg/ha) + Topsin M (1.0 кg/da)
	6	Cuprotsin Super M (2.0 kg/ha) + Topas 100 EC (150 ml/ha)

The plot with organically grown Cabernet Sauvignon grapes was treated against downy mildew (*Plasmopara viticola*) and powdery mildew (*Oidium tuckeri*) with the plant protection products Funguran OH 50 WP and Thiovit Jet 80 WG. They had been licensed for use in organic viticulture. Their composition and the doses in which they were applied in the trial were as follows: Funguran OH 50 WP (77% copper hydroxide), used for downy mildew control, at a dose of 1.5 kg/ha and Thiovit Jet 80 WG (80% sulphur), used for powdery mildew control at a dose of 3.0 kg/ha (before flowering of the vines) and 2.5 kg/ha (after flowering of the vines). Every year, a total of seven treatments with these products were carried out, in the period from mid-May to the end of July. Two counts were performed annually for establishing the variety's response to both diseases.

In the conventional cultivation of the Cabernet Sauvignon variety, five or six combined treatments against downy mildew and powdery mildew were performed every year (Table 1a, b).

Table 1b. Active substances of the fungicides used.

№	Fungicides	Active substances
1	Acrobat Plus WG	90 g/kg Dimethomorph + 600 g/kg Mancozeb
2	Bayfidan 250 EC	250 g/l Triadimenol
3	Cuproseyt Gold M	640 g/kg Mancozeb + Simoxanil 80 g/kg
4	Cuprotsin Super M	30% Cuprous oxychloride + 20% Mancozeb
5	Funguran OH 50 WP	77% Copper hydroxide (50% Cu)
6	Kumulus DF	80% Sulphur
7	Ridomil Gold MC 68 WG	4% Mefenoxam + 64% Mancozeb
8	Spirox	500 g/l Spiroxamine
9	Systane Super 24 EC	240 g/l Myclobutanil
10	Thiovit Jet 80 WG	80% Sulphur
11	Top Plus 70 WP	700 g/kg Thiophanate - methyl
12	Topas 100 EC	100 g/l Penconazole
13	Topsin M 70 WDG	700 g/kg Тиофанат - метил
14	Triomax 45 WP	120 g/kg Mancozeb + 40 g/kg Cymoxanil + 290 g/kg Copper oxychloride
15	Verita WG	667 g/kg Fosetyl - aluminum + 44.4 g/kg Fenamidone

For finding the variety response to downy mildew and powdery mildew, in organic and conventional cultivation, two records were made annually to establish the damage index on the leaves and clusters - in mid-June and the end of July. The damage index was calculated according to the Mc Kinnay formula (Arnaudov and Vassilev, 2020).

For maintaining the agrotechnical condition of the vineyard, mechanized green pruning of the vine contour was applied, and for weeds control in the area of the vine row - manual digging round and mechanical treatments.

Harvest, vinification, chemical composition

During the grape ripening period, the dynamics of the sugar accumulation in the grapes from the two studied variants was monitored annually. The harvest was manual, upon reaching technological maturity. The grapes in the amount of 30 kg of each variant was brought in plastic cassettes at the Experimental Winery of IVE – Pleven. It was processed according to the classic technology for red dry wine making in the conditions of micro-vinification (Yankov, 1992) - destemming, crushing, sulfiting (30 mg/kg SO_2), adding pure culture of dry wine yeast *Saccharomyces cerevisiae,* in the amount of 20 g/hkg. The alcoholic fermentation occurred at 28°C. After the process completion the young wines were separated from the solids and they were further sulfited up to 20 mg/l (organic sample) and up to 30 mg/l (conventional sample) free SO_2.

In the process of vinification, the basic requirements for organic wine making were observed. The grapes were processed with equipment without exposed metal parts. The alcoholic fermentation of the variants was carried out with wine yeasts that were not genetically modified. The vats used were made of stainless steel and for storing the wine – of glass. The vinification was carried out with less than the permissible doses of SO_2 for sulphitation.

To determine the chemical composition of the grapes and the experimental wines, the generally accepted methods in winemaking practice were applied (Chobanova, 2007; OIV, 2022; OIV, 2022b):

- Grapes composition:
    - sugars, g/l - hydrometer of Dujardin;
    - glucose, g/l – iodometric method;
    - fructose, g/l – calculation method;
    - total acidity (TA), g/l expressed as tartaric acid – titration with NaOH, OIV-MA-AS313-01;
    - tartaric and malic acid, g/l – method of Pochinok;
    - pH - pH-meter;
    - glucoacidimetric index (GAI) – calculation method as the ratio of sugars (%) and TA (g/l).
- Red experimental wines' composition:
    - sugars, g/l – Schoorl's method;
    - alcohol, vol. % - distillation method, Gibertini apparatus with densitometry of the distillate density;
    - total extract (TE) g/l - Gibertini apparatus with densitometry of the alcohol-free sample density;
    - sugar-free extract (SFE), g/l – calculation method (the difference between TE and sugars);
    - total acidity (TA), g/l expressed as tartaric acid – titration with NaOH, OIV-MA-AS313-01;
    - tartaric and malic acid, g/l – method of Pochinok;
    - volatile acidity (VA), g/l expressed as acetic acid – distillation method with subsequent titration with NaOH, OIV-MA-AS313-02;

- free and total SO_2, mg/l – iodometric method, OIV-MA-AS323-04B;
- total phenolic compounds (TPC), g/l expressed as gallic acid – spectrophotometrically by method of Singleton et Rossi;
- monomeric anthocyanins, mg/l – spectrophotometrically by method of Ribereau-Gayon et Stonestreet via pH changing;
- colour intensity I [abs. units] – method of Glories, OIV-MA-AS2-07B;
- colour tint T – method of Glories, OIV-MA-AS2-07B.

The organoleptic characteristics of the experimental samples were specified on a 100-point scale, for the indicators colour, aroma, taste and general impressions (Tsvetanov, 2001) by a 9-member tasting panel.

Statistical processing of the results

The presented experimental results for the composition of grapes and wines from each vintage were the arithmetic mean value from two parallel samples. In cases where a significant difference in the value of the analyzed indicator was found, a third sample was worked out and the two closest rates were taken into account.

The data obtained for the study period were statistically processed, represented by mean and standard deviation (± SD). Excel 2007 (Microsoft Office) was used for the determination.

RESULTS and DISCUSSION

Biological action of the plant protection products used in the experimental plantations to control downy mildew (*Plasmopara viticola*) and powdery mildew (*Oidium tuckeri*) (Table 3).

The proper implementation of the plant protection measures was of great importance for vines protection from downy mildew and powdery mildew. Depending on the degree of attack, they might significantly affect the quality and characteristics of the grape harvest (Parlevliet and McCoy, 2001; Kostadinova, 2010). It was found that after attack by these diseases, the ratio of the total phenols and the antioxidant activity in grapevine leaves increased more notably in the susceptible *Vitis vinifera* cultivars, compared to the varieties with more resistant genotype (Atak et al., 2017).

In this research, during the study of the organic production of Cabernet Sauvignon grapes, the applied fungicide Funguran OH 50 WP for downy mildew control had good or fairly good (2019) efficiency in terms of leaf mass, found annually at both recordings. In the period of reaching technological maturity, minor downy mildew attack was found both on the leaves and the clusters.

Damage to varying degrees was also observed when reporting powdery mildew on the clusters. For the period 2017-2020, the highest damage indices i.e. the greatest damage to the leaves by downy mildew was found in 2019 while by powdery mildew on the clusters in 2018. That confirmed the significant infection with the observed diseases under favorable climatic conditions for their manifestation and development in the months of May, June and July (Table 2).

In the plot with the conventional cultivation of the Cabernet Sauvignon variety, five combined treatments for downy mildew and powdery mildew control were made in 2017, while in the period 2018-2020 – six (Table 1a). As a result of the conventional plant protection measures, the foliage was slightly affected by downy mildew, with a higher damage index during the second recording. Its value was the highest in 2019. The reported damage index of the clusters by powdery mildew, as well as in the organic cultivation of the variety, was the highest in 2018.

Table 2. Climatic conditions during the period May-June, 2017-2020.

	Rainfall amount, mm/m^2				Mean air temperature ºC			
Year Month	2017	2018	2019	2020	2017	2018	2019	2020
May	135.0	38.6	121.2	74.2	17.1	19.5	17.1	17.0
June	66.0	170.0	86.0	58.4	22.8	21.6	22.7	21.4
July	220.4	189.6	94.6	59.0	23.7	23.0	23.5	23.6

The weather conditions during the growing season, especially in the months of May-July, significantly influenced the development of the monitored diseases and were of great importance for the harvest protection (Kostadinova et al., 2009; Kostadinova, 2012; Prajongjai et al., 2014). The observations for the onset of infection immediately after significant rainfall were confirmed. Throughout the study period, the data for the leaf mass and the clusters damage by downy mildew at the first reporting for both variants of treatments were close, with slightly higher damage index values for the organic production. At the second reporting, the values of the damage index were higher in the variant of organic growing, but the differences did not have a significant impact on the quality of the grape harvest. The damage index on the clusters by powdery mildew was higher in the variant of organic production, but the difference with the conventional one was insignificant (Table 3).

In the organic grapes growing, the amount of the input elemental copper (Cu) was especially strictly monitored. The used product Funguran OH 50 WP contained 770 g/l copper oxychloride, equivalent to 751 g/l elemental Cu. During the entire study period, the amount of pure copper input into the experiment for 1 year was 4.6 kg/ha, which was significantly below the maximum permissible rate for perennial crops after 2009 – 30 kg/ha Cu for a period of five consecutive years or 6 kg/ha per year (Regulation (BG) № 22/4.07.2001; Regulation (EU) № 889/5.09.2008).

Table 3. Influence and efficiency of the plant protection products used against downy mildew and powdery mildew in organic and conventional cultivation of the Cabernet Sauvignon variety.

Year	Variant	Described leaves			Described clusters		
		Total number	**Infected %**	**Downy mildew damage index**	**Total number**	**Infected %**	**Powdery mildew damage index**
2017	organic	200	3.5	0.83	100	6	2
	conventional	200	2.5	0.75	100	6	1.8
2018	organic	200	3	1.66	100	27	6.9
	conventional	200	0	0	100	13	4.0
2019	organic	200	20	5.0	100	9	1.5
	conventional	200	15	2.6	100	8	1.3
2020	organic	200	2	0.56	100	2	0.41
	conventional	200	0	0	100	2	0.41

Qualitative and quantitative indicators of the grapes and wine harvest of the Cabernet Sauvignon variety grown organically and conventionally.

The different way of cultivating the plantations in organic and conventional growing, including different practices for agrotechnics and plant protection, were decisive for the properties of the grapes and wine harvest.

Most studies on the physical and chemical composition of organically and conventionally grown grapes showed no significant differences. The rates of the investigated indicators (sugars, total acidity, pH, phenols, anthocyanins) were close. The differences were mainly between the individual harvests, due to the influence of the weather conditions of the year (Mulero et al., 2010; Hasanaliyeva et al., 2021; Ostroukhova et al., 2021).

In the present study, the laboratory analysis did not show either any significant difference in the main indicators of the chemical composition of Cabernet Sauvignon grapes grown organically and conventionally (Table 4). The average amount of sugars and total acidity was almost the same – respectively 238.50±11.27 g/l and 6.34±0.35 g/l (organic) and 235.50±14.00 g/l and 6.18±0.27 g/l (conventional). More significant differences in the value of these indicators were observed per harvests. In 2017 and 2020, the organic grapes had significantly better sugar accumulation. In 2019, the conventional variant had higher sugar ratios while in 2018 the difference between the two variants was small.

The organically grown grapes had higher total acidity, both per harvests and average value. This difference, between both variants, was the highest in the 2018 vintage (0.25 g/l) and the smallest in the 2020 vintage (0.08 g/l).

From the analyzed monosaccharides in grapes fructose predominated quantitatively over glucose. That revealed the grape harvest was carried out at technological maturity. Of the established organic acids, the malic was prevailing over tartaric acid in both variants. The data showed that organic grapes contained less tartaric and more malic acid compared to the conventional variant.

GAI was an indicator related to the wines' quality and their use. The higher values indicated an optimal sugars and acids ratio in the grapes, that was determining the harmony and balance in the taste of the obtained wines (Yankov, 1992). Both per harvest and the average values of the indicator the two variants were very close - 3.77±0.37 (organic) and 3.82±0.39 (conventional).

Table 4. Chemical composition of the Cabernet Sauvignon grapes for the period 2017-2020.

Indicators / **Variant**	**Vintage**	**Date of harvest**	**Sugars g/l**	**Glucose g/l**	**Fructose g/l**	**Total acidity g/l**	**Tartaric acid g/l**	**Malic acid g/l**	**pH**	**GAI**
organic	2017	26/09/	238.00	98.10	139.90	6.53	1.61	5.63	3.37	3.64
	2018	04/10/	223.00	87.15	135.85	6.70	1.54	5.87	3.21	3.33
	2019	19/09/	244.00	108.00	146.00	6.05	1.86	4.53	3.37	4.03
	2020	24/09/	249.00	102.60	146.40	6.08	2.36	3.96	3.26	4.09
	mean ±*SD*		238.50 ±11.27	98.96 ±8.85	142.04 ±5.08	6.34 ±0.35	1.84 ±0.37	5.00 ±0.90	3.30 ±0.08	3.77 ±0.37
conventional	2017	26/09/	222.00	102.60	119.4	6.40	2.59	4.83	3.35	3.47
	2018	04/10/	228.00	98.15	129.85	6.45	2.47	4.73	3.18	3.53
	2019	19/09/	254.00	102.60	151.40	5.89	2.36	3.93	3.40	4.31
	2020	24/09/	238.00	100.80	137.20	6.00	2.81	3.79	3.32	3.97
	mean ±*SD*		235.50 ±14.00	101.04 ±2.10	134.46 ±13.45	6.18 ±0.27	2.56 ±0.19	4.32 ±0.53	3.31 ±0.09	3.82 ±0.39

When studying the chemical composition of the obtained wines, most researches did not indicate either significant difference in the chemical parameters of the organic and conventional samples. More significant differences were observed only in individual indicators, depending on the harvest and production technology. Lorenzo et al. (2015), analyzed higher alcohol, residual sugars, total and volatile acidity, colour index in the organic wines and higher pH in the conventional ones. They explained the higher volatile acidity in the organic samples with the lower doses of SO_2 used. Ostroukhova et al.

(2021) identified more phenolic components, anthocyanins and correspondingly higher colour intensity in organic compared to conventional wines. Artem et al. (2021) indicated that in unfavorable years, with longer maceration in organic wines of the Fetească neagră variety, the ratio of phenolic acids, flavanols, flavonols and anthocyanins, especially malvidin-3-O-glycoside, increased.

In the present study, no significant differences were also observed in the ratios of most indicators from the chemical composition of the experimental Cabernet Sauvignon wines (Table 5).

The alcohol content of the samples corresponded to the sugars in the grapes of both variants. The average values of the variants were close - 13.77±0.40 vol. % (organic) and 13.61±0.67 vol. % (conventional). The wines from the 2019 and 2020 vintages had higher alcohol ratios in both variants. With the exception of the 2020 vintage, the organic samples had slightly higher alcohol rate.

The residual sugar content of the experimental wines was below 2 g/l (2.34 g/l in the 2019 vintage), which defined them as dry.

The total extract of the wine was the combination of all dissolved organic and mineral substances. In the experimental wines, the difference in the average values of the indicator between both variants was insignificant. The extract from the organic sample was by 0.5 g/l higher. The sugar-free extract of the wine was an indicator related to its taste and was decisive for its body. The residual sugars were not involved in its formation. The difference in the average rates between both variants was 0.42 g/l, in favor of the organic production. In 2017 and 2018 the wines from the organic variant had higher total and sugar-free extract. The difference was more than 1 g/l. In 2019 and 2020, the samples from the conventional production had higher extract values. In these harvests, the difference with the organic variant was less than 1 g/l.

No significant difference was observed in the total acidity of the experimental wines, both per harvests and average rates. In 2017 and 2018, higher acidity was recorded in the organic samples, in 2020 – in the conventional sample, and in 2019 it was identical for both samples. The amount of tartaric and malic acid was analyzed. Their reduction in wines was due to the course of physical, chemical and biochemical processes. The tartaric acid went down as a result of the formation of tartrate crystals that were precipitated. In red wines, the malic acid was converted into lactic acid after the malolactic fermentation (MAF). The obtained data showed that in the experimental samples at the time of the analysis, MAF had not occurred. That was established at a later stage. Wines from all variants and vintages had normal volatile acidity.

The phenolic components and anthocyanins content had been important for the taste and colour features of Cabernet Sauvignon wines. In the samples from both variants, more significant differences were observed in terms of the quantity ratio of these components. Throughout the study period, wines obtained from the conventional growing had higher rates of TPC and anthocyanins. The average values were 1.79±0.48 g/l and 335.57±49.94 mg/l, respectively, compared to the organic variants - 1.64±0.40 g/l and 317.92±77.79 mg/l. From the data analysis, it could be seen that in both variants, the samples from the 2019 harvest had the highest content of TPC and anthocyanins. Another generally established trend was that the lowest ratio of phenolic substances was reported in the samples from the 2020 harvest, and of anthocyanins - in the samples from the 2017 harvest.

The indicators related to the colour characteristics of wines were their intensity and tint. The tint rates did not show any deviations from the colour features of Cabernet Sauvignon wines. A correlation between the intensity rates and the anthocyanin content of the samples was observed. The wines made from the conventional growing had higher colour intensity (on the average 10.68±0.21 abs. units) than the organic variants (on the average 10.34±0.25 abs. units). In both variants, the samples from the 2017 harvest had the lowest intensity, and the 2019 harvest – the highest, which corresponded to the lowest and highest anthocyanin ratio found.

Table 5. Chemical composition of the experimental Cabernet Sauvignon wines for the period 2017-2020.

Indicators / **Variant**	**Vinatge**	**Alcohol vol. %**	**Sugars g/l**	**Total extract g/l**	**Sugar free extract g/l**	**Total acidity g/l**	**Volatile acidity g/l**	**Tartaric acid g/l**	**Malic acid g/l**	**pH**	**TPC g/l**	**Anthocyanins mg/l**	**Tint T**	**Colour intensity I [abs. units]**	**Free SO_2 mg/l**	**Total SO_2 mg/l**
organic	2017	13.38	1.44	25.40	23.96	5.93	0.42	1.45	4.16	3.33	1.58	207.39	0.63	10.09	20.50	61.20
	2018	13.50	1.50	24.30	22.80	5.63	0.66	1.49	3.29	3.44	1.60	351.30	0.68	10.39	19.80	52.40
	2019	14.23	2.34	24.80	22.46	6.15	0.62	1.41	4.50	3.40	2.17	374.43	0.68	10.60	17.20	55.30
	2020	13.95	1.10	23.80	22.70	5.85	0.60	1.41	3.19	3.39	1.21	338.56	0.72	10.28	18.50	58.80
	mean ± *SD*	13.77 ±0.40	1.60 ±0.53	24.58 ±0.68	22.98 ±0.67	5.89 ±0.21	0.58 ±0.11	1.44 ±0.04	3.78 ±0.96	3.39 ±0.05	1.64 ±0.40	317.92 ±77.79	0.68 ±0.04	10.34 ±0.25	19.00 ±1.46	56.93 ±3.87
conventional	2017	12.74	1.54	24.10	22.96	5.70	0.54	1.38	4.13	3.36	1.68	248.16	0.58	10.41	26.30	88.50
	2018	13.45	1.67	23.10	21.43	5.03	0.66	1.41	3.49	3.40	1.63	354.30	0.76	10.65	28.00	85.30
	2019	14.00	2.34	25.02	22.68	6.15	0.62	1.45	4.60	3.46	2.48	386.62	0.70	10.77	30.60	90.20
	2020	14.24	0.94	24.10	23.16	6.23	0.60	1.34	3.12	3.44	1.37	353.20	0.76	10.68	24.40	78.10
	mean ± *SD*	13.61 ±0.67	1.62 ±0.57	24.08 ±0.78	22.56 ±0.78	5.78 ±0.55	0.61 ±0.05	1.40 ±0.05	3.83 ±0.66	3.42 ±0.04	1.79 ±0.48	335.57 ±49.94	0.70 ±0.08	10.68 ±0.21	27.33 ±2.63	85.53 ±5.35

The amount of free and total SO_2 in organic wines had been the main indicator that was strictly monitored and limited by legislation (Parlevliet and McCoy, 2001; http://frenchscount.com/organic-wines; http://savagevines.co.uk/the-health-benefits-of-organic-wine). According to Regulation (EU) № 203/2012, the maximum permissible content of SO_2 in organic wines with a residual sugar content of up to 2 g/l was up to 100 mg/l for red wines and up to 150 mg/l for white and rosé wines. Due to the use of lower sulphiting doses, organic wines were at higher risk of increased volatile acidity (Artem et al., 2021).

In the experimental Cabernet Sauvignon wines made from the studied vintages, no ratio of SO_2 exceeding the dose determined by the legislation was analyzed. In the organic samples, the average content of free SO_2 was 19.00±1.46 mg/l and of total SO_2 56.93±3.87 mg/l, which was within the range specified in Regulation (EU) № 203/2012. That SO_2 ratio ensured the production of wines with normal volatile acidity (on the average 0.58±0.11 g/l). In the conventional samples, the average amount of free SO_2 was 27.33±2.63 mg/l, of total SO_2 85.53±5.35 mg/l and of volatile acidity – 0.61±0.05 g/l.

The chemical composition of wines determined their organoleptic characteristics. Most studies on the organic grape-growing and wine-making had not found an influence of the manner of cultivation and the harvest on the tasting qualities of the final product (Ostroukhova et al., 2021). According to other studies, due to differences in the volatile aromatic composition, floral aromas were more pronounced in organic wines, and fruity aromas in conventional wines (Lorenzo et al., 2015).

The results of the organoleptic analysis of the experimental wines were presented in Figure 1. In all vintages, the wines from the conventional variant were evaluated with more scores than the organic variant. The experimental samples from both variants had similar alcohol content, residual sugars, extract and total acidity. The differences were more pronounced in terms of phenolic components and color characteristics, which influenced the evaluated tasting indicators. The higher amount of TPC, anthocyanins and intensity in conventional wines predetermined their better taste and color properties and accordingly, their higher tasting scores. In both variants, the wines from the 2019 harvest had the best organoleptic features.

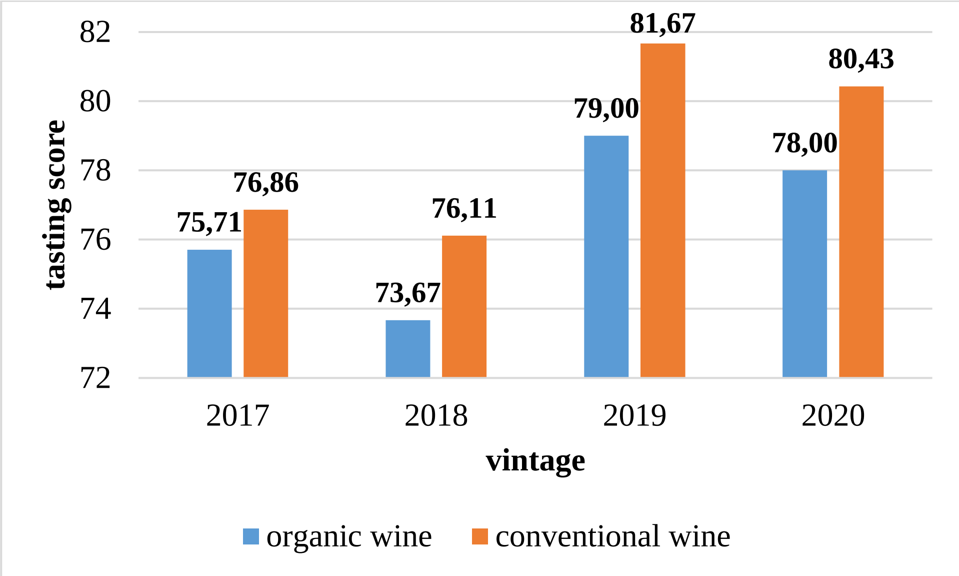

Figure 1. Tasting scores of the experimental Cabernet Sauvignon wines.

CONCLUSION

As a result of plant protection measures carried out during organic and conventional cultivation of the Cabernet Sauvignon variety, in the period of reaching technological maturity, a minor attack of downy mildew and powdery mildew was found on the leaf mass and the clusters. The damage index from both diseases was higher in the organic growing, but the found differences did not have a significant impact on the quality of the grape harvest.

The meteorological conditions during the growing season significantly influenced the incidence of the observed diseases. The emergence of infection was established in a period immediately after significant rainfall. The highest damage indices of downy mildew on the leaves were found in 2019 and by powdery mildew on the clusters in 2018.

The difference in the main indicators of the chemical composition of Cabernet Sauvignon grapes grown organically and conventionally was insignificant. The average amount of sugars, total acidity and glucoacidimetric index was similar. More significant were the differences in the rates of these indicators per harvests.

No significant differences were observed in the values of most indicators of the chemical composition of the experimental wines. The rates of alcohol, sugars, total acidity and extract in the samples from both variants were similar. More differences stood out in terms of TPC, anthocyanins and colour intensity. The wines obtained from the conventional variant had higher rate of these indicators.

According to their organoleptic characteristics and tasting evaluations, the wines from the conventional variant were superior to the samples obtained from the organic cultivation. That was due to the higher content of TPC, anthocyanins and intensity in the conventional wines, which predetermined their better taste and colour properties.

REFERENCES

Abrasheva, P., Bambalov, K. & Georgiev A. (2008). *Vine growing and winemaking*. Publishing House "Matkom", Sofia, pp. 15-20. (in Bulgarian)

Arnaudov, V. & Vassilev, D. (2020). Reaction of some nectarine cultivars to *Stigmina carpophila* (Lev.) Ellis. *Bulgarian Journal of Crop Science*, 57(4), 18-22. (in Bulgarian)

Artem, V., Antoce, A. O., Geana, E. I. & Ranca, A. (2021). Effect of grape yield and maceration time on phenolic composition of `Fetească neagră` organic wine. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 49(2), 12345.

Atak, A., Göksel, Z. & Çelik, H. (2017). Relations between downy/powdery mildew diseases and some phenolic compounds in *Vitis* spp. *Turkish Journal of Agriculture and Forestry*, 41(1), 69-81.

Chobanova, D. (2007). *Textbook for exercises in enology*. Academic Publishing House of University of Food Technology, Plovdiv, pp. 51-74. (in Bulgarian)

Dimitrova, D., Peikov, V., Dimitrov, V. & Dimitrova, V. (2013). Biological production of grapes and wine in Bulgaria - status and problems. *International scientific conference "Vine growing and winemaking", Institute of Viticulture and Enology, Odessa, Ukraine*. Conference proceedings, pp. 58-63. (in Russian)

Dutra, M. C. P., Rodrigues, L. L., Oliveira, D., Pereira, G. E. & Lima, M. S. (2018). Integrated analyses of phenolic compounds and minerals of Brazilian organic and conventional grape juice and wines: Validation of a method for determination of Cu, Fe and Mn. *Food Chemistry*, 269, 157-165.

Gonzalez, P. A., Parga-Dans, E., Blazquez, P. A., Luzardo, O. P., Peña, M. L. Z., Gonzalez, M. M. H., Rodriguez-Hernandez, A. & Andujar, C. (2021). Elemental composition, rare earths and minority elements in organic and conventional wines from volcanic areas: The Canary Islands (Spain). *PLoS ONE*, 16(11), e0258739.

Hasanaliyeva, G., Chatzidimitrou, E., Wang, J., Baranski, M., Volakakis, N., Pakos, P., Seal, C., Rosa, E. A. S., Markellou, E., Iversen, P. O., Vigar, V., Willson, A., Barkla, B., Leifert, C. & Rempelos, L. (2021). Effect of organic and conventional production methods on fruit yield and nutritional quality parameters in three traditional Cretan grape varieties: results from a farm survey. *Foods*, 10(2), 476.

Ivanova, D. (2019). Principles of organization of organic agriculture and its development in Bulgaria. *New Knowledge Journal of Science*, 8(2), 54-59. (in Bulgarian)

Kabakchieva, T. (2017). Organic farming – the future of the agricultural economy of Bulgaria. *Dialogue*, 4, 48-65. (in Bulgarian)

Kostadinova, M. (2010). About the control against grapevine mildew (*Plasmopara viticola*) in Bulgaria (review). *Viticulture and Winemaking*, 5, 26-44. (in Bulgarian)

Kostadinova, M., Lyubenova, T. & Genov, N. (2009). Phytopatological and entomological status of vineyards from the region of Pleven town under the drought conditions in 2007 and 2008. *Journal of Mountain Agriculture on the Balkans*, 12(5), 1089-1102.

Kostadinova, M., Lyubenova, T., Katerova, L. & Peykov, P. (2012). Pest management in organic production of grapes in the Institute of Viticulture and Enology, town of Pleven – results and problems. *International scientific conference "Scientific achievements - a contribution to efficient viticulture and winemaking", Institute of Viticulture and Enology, Pleven, Bulgaria*. Conference proceedings, pp. 159-166. (in Bulgarian)

Kostadinova, P. & Popov, V. (2015). Basic principles and methods of organic farming. *New Knowledge*, https://uard.bg/files/custom_files/files/documents/New%20knowledge/year1_n3/paper_kostadinova_y1n3.pdf. (in Bulgarian)

Lorenzo, C., Garde-Cerdan, T., Lara, J. F., Martinez-Gil, A. M., Pardo, F. & Salinas, M. R. (2015). Volatile composition of wines elaborated from organic and non-organic grapes. *Fermentation Technology*, 4(1), 1000117.

Mulero, J., Pardo, F. & Zafrilla, P. (2010). Antioxidant activity and phenolic compounds in conventional and organic red grapes (var. Monastrell). *CyTA – Journal of Food*, 8(3), 185-191.

Mulero, J., Zafrilla, P., Cayuela, J. M., Martinez-Cacha, A. & Pardo, F. (2011). Antioxidant activity and phenolic compounds in organic red wine using different winemaking techniques. *Journal of Food Science*, 76(3), C436-40.

OIV. (2022). *Compedium of international methods of wine and must analysis*. International Organization of Vine and Wine, v. 1, https://www.oiv.int/public/medias/8657/2022-eng-compediumvol1.pdf.

OIV. (2022b). *Compedium of international methods of wine and must analysis*. International Organization of Vine and Wine, v. 2, https://www.oiv.int/public/medias/8657/2022-eng-compediumvol2.pdf.

Ostroukhova, E., Peskova, I., Lutkova, N. & Stranishevskaya, E. (2021). The effect of the organic plant protection system on the chemical composition and quality of grapes and red wines. *E3S Web of Conference*, 285(5), 05024.

Parlevliet, G. & McCoy, S. (2001). Organic grapes and wine: a guide to production. *Department of Primary Industries and Regional Development, Western Australia, Perth, Bulletin 4516*.

Prajongjai, T., Poolsawat, O., Pornbungkerd, P., Wongkaew, S. & Tantasawat, P. A. (2014). Evaluation of grapevines for resistence to downy mildew (Plasmopara viticola) under laboratory and field conditions. *South African Journal of Enology and Viticulture*, 35(1), 43-50.

Regulation (BG) № 22/4.07.2001 on the organic production of plants, plant products and foods of plant origin and its marking on them. https://www.mzh.government.bg/MZH/Libraries/%D0%9D%D0%BE%D1%80%D0%BC_%D0%90%D0%BA%D1%82%D0%BE%D0%B2%D0%B5-%D0%9D%D0%B0%D1%80%D0%B5%D0%B4%D0%B1%D0%B8/Naredba_22_04072001.sflb.ashx. (in Bulgarian)

Regulation (EU) № 889/5.09.2008 laying down detailed rules on organic production and labelling of organic products https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2008R0889:20100701:EN:PDF.

Regulation (EU) № 203/2012 as regards detailed rules on organic wine. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:071:0042:0047:en:PDF.

Regulation (EU) № 848/2018 on organic production and labelling of organic products https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018R0848.

Tsvetanov, O. (2001). *How to taste wine*. Publing House “Gourmet”, Sofia, pp. 43-46. (in Bulgarian)

Vachevska, D., Dimitrov, V. & Simeonov, I. (2007). Biological production of grapes and wine – state, tendencies and possibilities for development in Bulgaria (review). *International scientific conference “Sustainable development of viticulture and winemaking based on knowledge”, Institute of Viticulture and Enology, Pleven, Bulgaria*. Conference proceedings, pp. 256-264. (in Bulgarian)

Yankov, A. (1992). *Technology of winemaking*. Publing House “Zemizdat”, Sofia, pp. 141-175. (in Bulgarian)

http://frenchscount.com/organic-wines

http://savagevines.co.uk/the-health-benefits-of-organic-wine

https://ec.europa.eu/info/food-farming-fisheries/farming/organic-farming/organics-glance_bg