Journal of Agricultural, Food and Environmental Sciences Vol 80 No 1 (2026) 26-37
DOI:

Original scientific paper

CHEMICAL COMPOSITION AND SENSORY CHARACTERISTICS OF CABERNET SAUVIGNON WINE PRODUCED FROM GRAPES TREATED WITH INACTIVE YEASTS BY FOLIAR APPLICATION

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ABSTRACT
The aim of this investigation is to evaluate the effects of the application of a product consisting yeast derivatives on the phenolic maturity and composition of Cabernet Sauvignon grapes and wine in Kratovo region. Foliar spraying with LalVigne Mature in the vineyard was applied, two applications in veraison and untreated control. Spraying with yeast derivatives did improuve phenolic content by increasing the accumulation of anthocyanins and tothal phenols in the wines from treated vineyard. Analyses of the chemical and phenolic composition, as well as determination of the sensory characteristics of the wine, were performed. In wines obtained from the treated vineyard, a higher concentration of total anthocyanins, total polyphenols and procyanidins (which give softness to the tannins) was confirmed compared to the wine obtained from the control grapes where the concentrations of flavantriols are higher, which express the immaturity of the seed of the grain which gives the feeling of dryness. The chemical analyses didn't show significant differences in terms of parameters such as: alcohol, total acids, pH, total extract and volatile acids. According to sensory analysis, characteristics of the wines obtained from the treated grapes and the control, significant differences were observed in terms of the descriptors of taste and aroma. The wine made from the treated grapes is characterized by pronounced fruitiness and harmony, softness and fullness in the taste compared to the control wine which is characterized by greater bitterness, vegetality and astringency in the taste.

Keywords: Cabernt Sauvignon, foliar spraying, inactive yeast, Kratovo, phenolic maturity.

INTRODUCTION
Grapevine cultivation in Macedonia began under the dominance of Mediterranean civilizations, with the greatest influence from the Roman Empire. Over time, climate change has caused an increase in average temperatures during the grape ripening season, leading to an advance in the phenological stages of the vine and earlier harvests. This can result in the production of grapes with greater accumulation of sugar in the berries, but at the same time, incomplete phenolic maturity, which jeopardizes the quality of the wine. The aim of this research is to evaluate the effects of the application of a new product, consisting of yeast derivatives, on the phenolic maturity and composition of Cabernet Sauvignon grapes and wines from the Kratovo region. Growing grapes in regions with a cooler climate, such as the Kratovo region and the location of the plantation where there is no possibility of irrigation, represents a great challenge for the grapes to achieve phenolic maturity, so that the wine that would be obtained from phenolic ripe grapes would be characterized by good color, full body, structurally well-balanced and rich in aromas of ripe grapes (Vojnoski et al., 2009). This

describes the development of the grapevine in the Republic of Macedonia, the climatic conditions present in Macedonia, the presence of grapevines in the territory of Macedonia, as well as the areas planted with grapevines and the percentage of presence of red varieties and white grape varieties in each vineyard, also giving a recommendation to carry out climatic zoning and the correct arrangement of varieties according to the viticultural units.

Unwin, 1991, provides an introduction to the history of viticulture and the wine trade from prehistory to the present day. The influence of different grape varieties, the emergence of new methods of vinification, the importance of geology and soil type and the role of phylloxera, all these factors are considered to have played a significant role in the creation of wine-growing landscapes throughout the world.

In a study by a group of authors (Villangó et.al., 2015) conducted in Hungary, the effects of the application of yeast derivatives on the phenolic maturity of Syrah grapes, as well as on the phenolic composition and concentration of the wine, were analyzed. The results analyzed from two harvests show that their application led to more optimal harvesting conditions. In addition, a higher level of phenolic maturity was achieved in both warmer (2012) and cooler (2013) harvests. The application of this foliar spray resulted in wines that were more balanced and showed more flavors and complexity compared to those wines obtained from unsprayed vines. The same authors obtained preliminary results that suggest that yeast derivatives may help in colder and less optimal harvests by improving the ripening process, which leads to wines with greater enological potential.

Harris, 2016 in his study analyzed the impact of LalVigne spray (ScottLabs) on the maturity, chemical and sensory qualities of the Merlot variety. In his study, a comparison was made between unsprayed and sprayed vines in every second row with “LalVigne Mature”. The results showed that in the treated vines, tannins and anthocyanins in the grape berries increased, but they reduced the mass of the grapes (but not the mass of the berries). In terms of chemical parameters, no major differences were recorded between the treated and untreated vines. Also, in terms of the aromatic profile and the body of the wines, no major differences were recorded.

Researchers (Vilango et al., 2015) analyzed in their study the application of yeast derivatives (LalVigne® MATURE, Lallemand Inc.) on the phenolic maturity of Syrah grapes, as well as on the phenolic composition and concentration of the wine. The results show that its application leads to more optimal harvesting conditions. The application of this foliar spray results in wines that are more balanced. Preliminary evidence was also obtained suggesting that LalVigne® MATURE could also help in colder and less optimal harvests, by improving the ripening process, leading to wines with greater enological potential.

Kratovo vineyard is located in the northeastern part of Macedonia and includes the localities of Kriva Palanka and Kratovo. Of the environmental factors in which grape varieties are grown, the climatic and soil conditions have the greatest influence. The Kratovo vineyard belongs to the eastern region, which accounts for approximately 4% of the total production in Macedonia. The vineyards are generally located at 440-650 m above sea level, on hilly and undulating terrain, with medium-slight slopes with different exposures. The locality of Zeleznica (KO Zeleznica) where the plantation of the Cabernet Sauvignon variety is established, is located at an altitude of 590 m. The soil type is clay soil, suitable for growing vines, weakly alkaline and characterized by a moderately acidic substitution pH reaction of the soil solution without any carbonates. The soil is weakly humus and is characterized by good affinity with the total forms of nitrogen and central Europe with its physiologically used forms. According to the content of the physiologically used forms of phosphorus and potassium, the soil is categorized as a well-fertile soil.

The climate is temperate-continental with strong gusts of northerly winds. The winds provide good ventilation of the vineyards, thus reducing the number of sprayings of the vines with protective agents. Over 110 days a year have temperatures above 25 ^{o}C. In the Kratovo region, the average temperature during the vegetative period is 16.6 ^{o}C and the average amount of precipitation is 65 L/m^2.

The vegetation of the grapevines in the Kratovo vineyard begins towards the end of April. The flowering of the grapevines, depending on the variety, in this region is at the beginning of June. The beginning of the grape harvest depends on the vegetation year and generally for the Cabernet Sauvignon variety it is towards the middle of October.

The relief structure of the vineyard, the climate and the soil types are some of the basic factors that contribute to the creation of specific conditions for the development of quality viticulture and wine production. For the successful cultivation of the grapevine, in addition to soil and climate factors, water also plays an important role. Although the grapevine is resistant to drought, it still requires a certain amount of moisture for its growth and development.

Air humidity is another important factor that contributes to the development of the vine during the vegetative period. Its influence is expressed through the intensification of the transpiration process and other physiological processes related to it, but also the development of fungal diseases (Winkler et al. 1974). The percentage of high humidity during the research was 66.5 %.

Sunlight, as an energy source for photosynthesis, is the most important climatic factor that favors the synthesis of phenolic compounds, increases titratable acidity, and also influences the synthesis of aromatic compounds in grapes.

MATERIALS AND METHODS

Field activities began in August 2025. The experiment was set up on the vineyards of the "Monteko" winery in the Kratovo vineyard, on a plantation of Cabernet Sauvignon grapes in the "Zeleznica" locality, a place called "Ramniste". The plantation is located at an altitude of 590 m above sea level, with a total area of 5.1 ha.

The Cabernet Sauvignon plantation is trained using a trellis system, which uses a trellis support structure consisting of concrete posts (internal and external anchors) and metal wire. The row spacing is 2.4 m and the vine spacing is 1 m. The vine training system is a duble Guyot with two spures (two winter buds) and two canes with 8 winterbuds.

The yield of the grapevine and the quality of the grapes and wine depend on the cultivation of the grapevine, i.e. on the application of appropriate agrotechnical measures in order to obtain regular and quality yields for a longer period. During the vegetation period, all standard agrotechnical and ampelographic measures for the production of wine grapes were applied to the analyzed plantation.

This grape variety originates from the Bordeaux vineyards. It belongs to the ecologically geographical group of Western European varieties, subgroup Gallica.

The variety is most common in France, the Bordeaux region. It is spread throughout the world and on all continents and everywhere provides high quality wines. The shoots are thick, with short internodes and covered with moss. The bark is colored brown-red. The leaf is medium-large, five-lobed, with deep and overlapping sinuses that form circular openings, characteristic of this variety. In autumn, the leaf turns yellow, with dark brown and red spots. The cluster is medium-large, with a cylindrical-conical shape, compact or slightly loose. The grain is small, with a round shape. It has a thick, tough shell, colored dark blue, pollinated with waxy pollen. The flesh is juicy, tasty and colorless. Ripening in this region is towards the end of October, the vegetation ends on time, and the shoots ripen well. It is fertilized regularly and well, and it belongs to the group of low-yielding varieties. It produces the best results on deep, moderately moist and calcareous soils. It is moderately drought resistant.

Cabernet Sauvignon grapes contain an average sugar concentration of around 24 ^{0}Brix and a total acid content of around 7 g/L. The resulting wines are characterised by an alcohol content of around 14 vol % and a total acid content of 5 – 6.5 g/L.

As a variety, it provides raw material for the production of high-quality red wines. Due to its favorable agrobiological and technological characteristics, as well as its resistance to low temperatures, the Cabernet Sauvignon variety can be represented in the assortment of vineyards located at higher altitudes.

Cabernet Sauvignon grapes were used as the material for the study. On the same plantation with Cabernet Sauvignon on an area of one hectare, a foliar application with inactive yeasts (LalVigne MATURE) was made during the budding stage, at the moment when about 5% of the graines were colored, while the second application was made 10 days later. Figure 1 schematically shows the moment of budding of the bunch, when the first foliar spray with LalVigne MATURE should be applied.

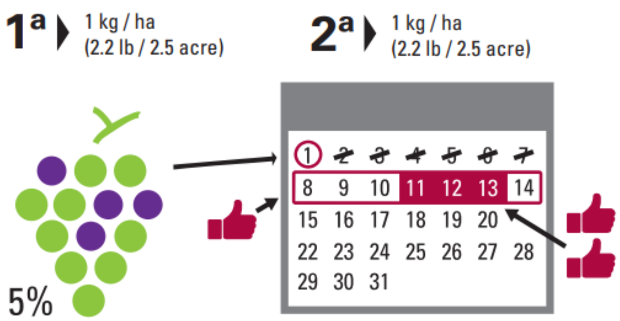
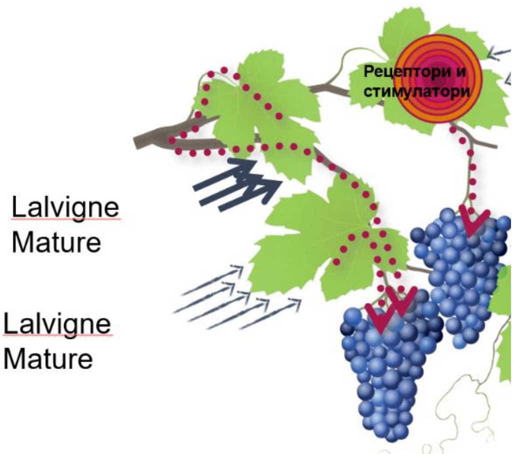


Figure 1. Stages of foliar spray application LalVigne MATURE

The recommended dose for applying inactive yeast (LalVigne MATURE) is 1 kg/ha, the same amount is dissolved in 200 to 600 liters of water per hectare before application, depending on the water consumption of the atomizer per unit area.

Inactive yeast stimulates the vine, increasing and accelerating the natural biosynthetic pathway that produces secondary compounds responsible for phenolic maturity and increased wine quality. Figure 2 shows the mode of action of inactive yeast.



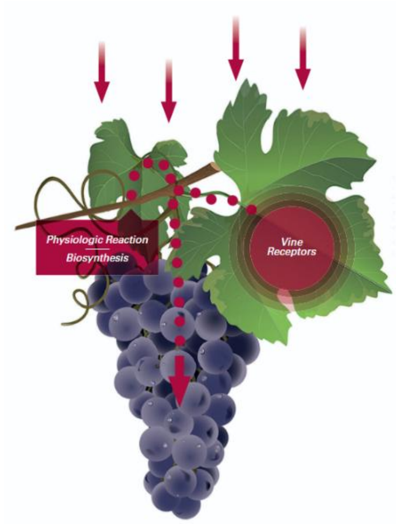


Figure 2. Action of inactive yeast

The grapes were harvested at the end of October, at the stage of full physiological and technological maturity. The grapes were harvested manually in 20 kg plastic crates. Before the start of the harvest, a chemical analysis of the grapes was performed, which included the following parameters: pH, sugars and total acids from the surface that was treated with "LalVigne MATURE" and from the surface that was not treated with inactive yeasts.

After manual selection, the grapes passed through a destemming machine. Then, the berries continued to a crasher and after grinding the grapes, they fell into the peristaltic pump container where 5% sulfuric acid was automatically added in an amount of 30 mg/L, which protected the grape juice from oxidation during the transport to the fermenter and in the fermenter itself.

1 g/hL of the EX-V enzyme from Lalemand was added to the pre-fermentation maceration to ensure greater extraction of phenolic compounds, better color and stability.

The solubility of oxygen is higher at lower temperatures, and the maceration itself and the mixing of the mash intensify the oxidation process. The use of enzymes themselves is limited due to the low temperatures, and therefore the activity of the enzyme is unnoticeable. Finally, in order to start the alcoholic fermentation, the grape must needs to be heated, consuming a certain amount of energy. In order to avoid all the risks that cold maceration brings, a pre-fermentative maceration was applied with “BIODIVATM” (a pure culture of *Torulaspora delbrueckii*) which is used to improve the aroma and complexity of the mouthfeel in white and red wines. Used in sequential inoculation with a compatible selected yeast *Saccharomyces cerevisiae* studied and recommended by Lallemand, “BIODIVATM” will help control the development of the aromatic complexity of the wine by favoring the perception of certain esters, without overloading the wines.

Due to its low production of volatile acids and its tolerance to osmotic shock, "BIODIVA^{TM}" is a particularly suitable preparation for the fermentation of late harvest and ice wines.

The advantages of "BIODIVA^{TM}" over cold pre-fermentative maceration are: optional cooling of the grapes to 4-10 °C, since at 16 °C there is already slow fermentation, the use of enzymes at a temperature of 16 °C is possible for faster color extraction and early extraction of tannins from the skins, which allows for early color stabilization, with complete control over the microflora, wild yeasts provide 2-3 times more pronounced betaglucosidase activity compared to *Saccharomyces* yeasts, making the wine more complex, as a result of the activity of the wild yeast, the mash is protected by SO_2, which makes it easier to manipulate the extraction, and thus reduces oxidation and the mash does not need to be heated for inoculation of *Saccharomyces* yeast, which saves energy.

Before inoculation with "BIODIVA^{TM}" we need to ensure that the grape must has free SO_2 less than 15 mg/L, and the temperature of the grape must is not less than 16 °C.

The recommended dose of “BIODIVA^{TM}” is 25 g/hL which is rehydrated in water at 30°C. The rehydrated yeast should be acclimatized at a temperature close to the temperature of the must to avoid temperature shock. Grape juice is added in the amount of rehydrated yeast with stirring, until the yeast suspension avoid the temperature of 10°C of the juice to be inoculated. The total rehydration time should not exceed 45 minutes. 24 hours before fermentation, non-saccharomyces yeast “BIODIVATM” was added in order to obtain greater extraction of anthocyanins, aromaticity, fullness and phenolics. After 48 to 72 hours of adding “BIODIVATM”, selected wine yeast “LalVigne D 254” was added at a dose of 25 g/hL, as well as oak chips at a dose of 3 g/hL.

During alcoholic fermentation, the processes of “Delestage” and “Remounting”, which are common in the production of red wine, were performed. The grapes from the treated area with “LalVigne MATURE” and the grapes from the unsprayed area, which serves as a control, were processed in the same way and treated with the same oenological agents.

The grape must from the treated area after processing is processed in a fermenter with a capacity of 50 hL, which is equipped with a heating and cooling system, which allows us to control the temperature during alcoholic fermentation and post-fermentative maceration. Similarly, the grape must from the untreated area is processed in the same 50 hL fermenter, which is then inoculated with a dry yeast culture Lalvin D254 at a dose of 25 g/hL and oak chips at a dose of 3 g/hL.

The fermentation of the grape must from the treated and untreated areas takes place separately. The following variants were taken:

• Control – grape must from the untreated area of the vineyard filled in a 50 hL stainless steel container, inoculated with Lalvin D254 yeast at a dose of 25 g/hL.

• Variant 1 – grape must from the treated area of the vineyard with “LalVigne MATURE” with two applications of 1 kg/ha, filled in a 50 hL stainless steel container, inoculated with Lavin D254 yeast at a dose of 25 g/hL.

The temperature during alcoholic fermentation did not exceed more than 23 ^{o}C, and during fermentation Fermaid E complex food was added twice at a dose of 15 g/hL. Sugar content analyses were performed daily. After completion of alcoholic fermentation, the young wine was separated from the lees in another tank, mild sulfuration was performed (10 mg/L), and then the wine was returned to the tank with pomace, the temperature was reduced to 10 ^{0}C and left in contact with the solids for a period of 40 days at low temperature (extended maceration), in order to obtain greater complexity obtained through the polymerization of tannins during that period.

After settling the young wine for 48 hours, the young wine was separated from the coarse sediment and sulfurized with 1 ml/L of 5% sulfurous acid, to avoid oxidation and spoilage processes in the wine.

After completion of alcoholic fermentation and post-fermentative maceration, quality control was performed separately for the two experimental wines at the Laboratory for Wine and Alcoholic Beverages of the Institute of Agriculture- Skopje, according to OIV approved methods, with analysis of the following parameters: specific gravity, alcohol, density, total extract, sugar, dry extract, pH, total acids, volatile acids, free and total SO_2. Determination of phenolic compaunds and descriptive sensory analysis were performed.

The content of free and total SO2, as well as the content of total acids, were determined by classical volumetric methods, and the content of volatile acids, alcohol and total extract was based on distillation using the Gibertini Super DEE instrument and determination with a Gibertini alcomat. Five wine experts were involved in the sensory evaluation of the tested wines. Both wine samples were evaluated during a single tasting and all tasting results were statistically processed. Total polyphenols in wine were determined by the Folin-Ciocalteu method (Singelton, Slinkar 1999). For quantification of total flavan-3-ols in wine, p-dimethylaminocinnamaldehyde (p-DMACA) was used, according to Di Stefano et al., 1989. The content of total anthocyanins was performed according to the Acid ethanol method, described by Somers et al., 1977. The color intensity of a wine depends on the composition and concentration of anthocyanins. It is defined as the sum of absorbances at different wavelengths (420, 520 and 620 nm). The obtained values are used to determine the color intensity (CI) and hue (H), red – (%R), blue – (%B) and yellow – (%Y) spectrum.

RESULTS AND DISCUSSION

The results obtained from the chemical analyses of the grapes are presented in Table 1. From the results, it can be concluded that there are no major differences in the chemical composition of the treated and untreated grapes, with slightly higher pH and sugar measured in the untreated grapes, while higher total acids are observed in the treated grapes.

The results obtained from the analyses of phenolic compounds are presented in Table 2. It can be noted that there is a difference in grape juice from treated and untreated grapes. The content of total anthocyanins in the skin of untreated grapes is 2.21 g/kg, while in the treated grapes it is 2.85 g/kg. From the content of anthocyanins in the skin, we can conclude that the coloring of grapes treated with “LalVigne MATURE” is better compared to the control.

Table 1. Grape analysis results

	Untreated grapes	Treated grapes
pH	3.78	3.68
Sugar /g/L	230	224
Total acids /g/L	4.8	5.2

Table 2. Results for phenolic compounds in grapes of the Cabernet Sauvignon variety

	Total anthocyanins/g/kg	Total flavan-3-ols/g/kg	Total phenols/g/kg
Untreated grapes skin	2.21	1.85	8.930
Treated grapes skin	2.85	1.53	10.370
Untreated grapes seeds	/	21.36	62.50
Treated grapes seeds	/	20.55	65.10

According to the results obtained for flavan-3-ols in the skin of untreated grapes, there is a greater amount compared to treated grapes, i.e. 1.85 g/kg was measured in untreated grapes, while 1.53 g/kg in treated grapes. Also, the results obtained for flavan-3-ols obtained from the seeds of untreated and treated grapes give identical results, i.e. a greater amount of flavan-3-ols was obtained in untreated grapes in an amount of 21.36 g/kg, compared to treated grapes, where 20.55 g/kg was obtained.

The analyses of total phenols in the skin and seeds of treated and control grapes show that higher values of total phenols are found in the skin and seeds of treated grapes, compared to the untreated control grapes. In the skin of treated grapes, 10.37 g/kg were obtained, while in the untreated grapes 8.93 g/kg. Also, a higher amount of total phenols was found in the seeds of treated grapes (65.10 g/kg), compared to untreated grapes (62.5 g/kg). It follows that the treated grapes have better phenolic maturity compared to the control grapes. The chemical analyses of the experimental wines obtained after completion of alcoholic fermentation are shown in Table 3.

Table 3. Results obtained from the chemical analysis of Cabernet Sauvignon Wine

	Control wine	Variant 1
Specific gravity	0.9936	0.9947
Dry extract /g/L	29.4	31.5
Alcohol / vol %	13.70	13.50
Total acids /g/L	4.6	5.2
Volatile acids /g/L	0.40	0.41
Free SO_2 /mg/L	28.16	32.00
Total SO_2 /mg/L	51.20	58.88
pH	3.67	3.46
Density /g/mL	0.99179	0.99289

Total acids (TA) are compounds that play an important role in determining the character and quality of wine, not only in giving a fresh taste, but also in modifying the perception of other taste sensations, by reducing the perceived sweetness. During fermentation and aging, they are involved in reactions that lead to the formation of esters, which are important for the freshness and aromaticity of wines.

From the results shown in Table 3, it can be concluded that the total acids (TA) in the control sample are lower compared to those in variant 1. In the control sample, the concentration of total acids is 4.6 g/L, while in variant 1 the obtained content of total acids is 5.2 g/L. From this we can conclude that the wine from variant 1 is fresher and has more intense aromas compared to the control wine.

From the results shown in Table 3, it can be concluded that the pH value of the control wine (3.67) is higher than the pH of variant 1 (3.46), which implies that variant 1 wine will be microbiologically more stable, have a more pronounced bright red color and have the potential for longer aging in the bottle.

The content of volatile acids in wines is an indicator of the quality of the raw material and the correct course of the vinification process. The content of volatile acids in the obtained experimental wines is 0.40 g/L (control) and 0.41 g/L (variant 1). The obtained values are within normal limits according to Macedonian legal regulations. Also, these values for volatile acids indicate that the raw material was of high quality without the presence of any diseases and anomalies and the vinification processes themselves in the control wine and the variant 1 wine were performed professionally without any errors in the process itself, which ultimately results in the production of quality wines with a low content of volatile acids.

Table 3 also shows the results for the alcohol content. In the control sample, the alcohol content is 13.7 vol%, while in variant 1 the alcohol result is 13.5 vol%. From the results obtained, it can be concluded that the treatment with the foliar spray "Lalvigne Mature" does not have any significant impact on the percentage of alcohol.

Total extract is another indicator of the composition and quality of wines. Wines with a low extract content are inharmonious and empty, while wines with a higher extract content are characterized by harmony and fullness. The content of total extract in wines depends on the conditions of vine cultivation, the degree of ripeness of the grapes and the applied winemaking technology (Ribéreau-Gayon et al. 2000). The high value for total extract obtained in wines is an indication that full-bodied wines can be produced from the Cabernet Sauvignon variety. The values for total extract, which were measured in the control wine and variant 1, are 29.4 g/L and 31.5 g/L respectively. This indicates that the wine from variant 1 is more harmonious and has a fuller body compared to the control wine.

Phenolic compounds play an essential role in determining the organoleptic characteristics of wines. They determine its sensory properties such as: color, astringency, bitterness and flavor (Landete, 2011; Alcalde et al., 2014), which affect the stability of the wine during oxidation processes and are synthesized as secondary metabolites in the grapes, while in the wine they are extracted during maceration. Table 4 shows the results for the phenolic compounds of the Cabernet Sauvignon wine of the experimental wines after completion of alcoholic fermentation.

Table 4. Chemical analysis of phenolic compounds in Cabernet Sauvignon wine

	Total anthocyanins/g/kg	Total flavan-3-ols/g/kg	Total phenols/g/kg	Procyanidins /mg/L
Control	265	434	1554	2425
Variant 1	384	411	1664	3634

During the vinification process of red wine, phenolic compounds are extracted from the seed in a higher percentage and in a lower percentage from the skin of the grain and with maceration there are transferred to the must. The extraction of phenolic compounds in the must depends on the grape variety, climatic factors, the degree of ripeness of the grapes, the duration of contact with the skin, the use of pectolytic enzymes for maceration and the maceration temperature.

According to Kennedy, 2008, maceration has a major impact on the concentration of phenolic compounds present in the final wine, as anthocyanins are extracted early in the vinification process and at the beginning of fermentation, when they reach their maximum.

From the results shown in Table 4, it can be concluded that the content of total phenols is higher in the wine from treated grapes compared to the control wine. The content of total phenols was 1554 mg/L in the control wine, while in variant 1, 1664 mg/L was obtained. The higher value of total phenols in the wine from treated grapes is the result of the application of the foliar spray.

In this study, the content of colored substances (anthocyanins) in the experimental wines ranged from 265 mg/L in the control wine to 384 mg/L in the wine from treated grapes. The higher level of anthocyanins in the wine from treated grapes is also a result of the foliar application, which contributes to this wine having a more intense purple-red color compared to the control wine from untreated grapes.

Flavan-3-ols are a large family of phenolic compounds responsible for astringency, bitterness, and structure in wines. Flavan-3-ols originating from the skin are extracted in the early stages of alcoholic fermentation, while the extraction of flavan-3-ols from the seed depends on the temperature, alcohol content and duration of maceration.

Flavan-3-ols have the ability to bind with anthocyanins and form stable pigments, thus protecting the wine from oxidation processes.

The contents of flavan-3-ols are shown in Table 4, from which it can be concluded that the concentration in wine from untreated grapes is higher (434 mg/L), compared to wine from untreated grapes (411 mg/L). It follows that in wine from untreated grapes, bitterness and astringency will be more pronounced compared to wine from treated grapes.

Procyanidins or condensed tannins are produced by the polymerization of flavan-3-ols. Procyanidins belong to two groups: prodelphinidins and procyanidins, which in an acidic environment release delphinidin or cyanidin. According to Czochanska, 1979, procyanidins contain catechin and epicatechin, while prodelphinidins contain gallocatechin and epigallocatechin. In young wines, the largest percentage of procyanidins are dimers and trimers.

Structural differences have been observed between procyanidins found in the skin, stem and seed. Tannins from the seed are less polymerized than tannins present in the skin (Hayasaka & Kennedy, 2003), which can contain up to 74 flavanols. During vinification, the extraction of flavan 3-ols from the seeds, due to their poor water solubility and dependence on ethanol content, occurs in the later stages of alcoholic fermentation and lasts until the post-fermentation phase (Canals et al., 2005; Morel-Salmi et al., 2006).

In this paper, the levels of procyanidins measured in wine from untreated grapes are much lower than in wine from treated grapes. In wine from untreated grapes, 2425 mg/L was obtained, while in wine from treated grapes, the procyanidin content is 3634 mg/L. From the results obtained, we can conclude that in wine from treated grapes, procyanidins or condensed tannins are at a much higher level, which gives the wine itself greater fullness and balance.

Quantitative descriptive analysis is a procedure for assessing the qualitative properties of wine through the evaluation of the organoleptic characteristics of a given product. The sensory analysis of the tested wines was conducted at Institute of Agriculture - Skopje by a five-member committee. Descriptive methods are used to provide more comprehensive product profiles, asking evaluators to identify the various characteristics of the product and quantify the characteristics.

The tasting committee determined nine descriptors: floral aroma, fruitiness (black fruit), fruitiness (red fruit), bitterness, astringency, vegetality, harmony, fullness, and soft tannins, through which the qualitative properties of the tested wines were described and evaluated.

Each of the listed descriptors was determined on a score scale from 1 to 10 in the presence of a control variant. The results obtained from the sensory evaluation were mathematically processed and presented in a spider diagram, which is presented below in Diagram 1.

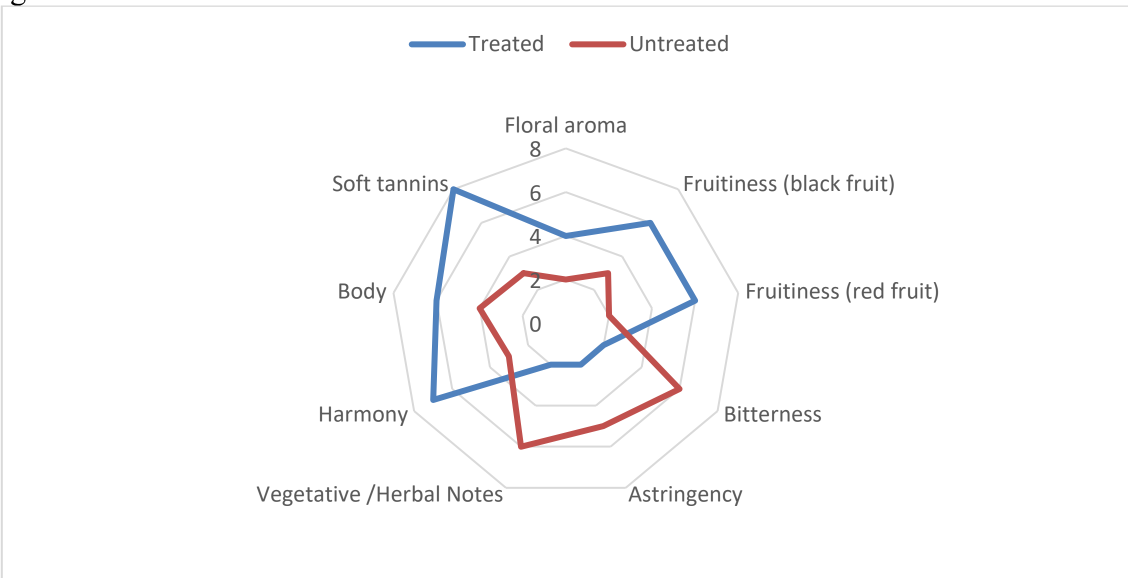


Diagram 1. Sensory analysis of Cabernet Sauvignon wines

The spider diagram is a graphic representation of the presence of the individual sensory components analyzed. Each of the analyzed wines has its own "fingerprint" which can be seen from Diagram 1. If we analyze the diagram, we can see that the wine made from grapes treated with "Lalvigne Mature" has a more balanced ratio between the individual descriptors. In the wine from treated grapes, the values of the descriptors for bitterness, astringency and vegetality are lower compared to the wine from untreated grapes (control), which indicates positive characteristics from the use of the foliar spray "Lalvigne Mature", and we see the same through the other descriptors. For example, the control wine has lower values for the descriptors floral aroma, fruitiness (black fruit), fruitiness (red fruit), harmony and fullness. All of these descriptors describe the desired components in a wine that are present in wine obtained from grapes treated with "Lalvigne Mature".

CONCLUSION

During 2025, research was conducted on Cabernet Sauvignon in the Kratovo region, which has a cooler climate, although the grape variety is predominantly found in warmer climate regions. The aim of this research was to accelerate ripening and phenolic maturity by applying an inactive yeast preparation with the commercial name "Lalvigne Mature". The Kratovo region has short vegetation and higher altitude, which means that grape ripening is later compared to regions with warmer climates. The tests fully confirmed the positive impact of the inactive yeasts that were applied in some of the Cabernet Sauvignon vineyards. It has been proven that the application of this type of product (inactive yeast spray) increases the secondary metabolism of the grapevine and accelerates the maturation processes of phenolic compounds in the grapes, which was demonstrated by the increased content of anthocyanins and total phenols in the skin, as well as in the seeds of treated grapes compared to untreated ones.

Also, the research confirmed the positive impact of the treatment of the vineyard with inactive yeasts ("Lalvigne Mature") on the quality of the resulting wines. In the wines obtained from the treated vineyard, a higher concentration of total anthocyanins, total polyphenols and condensed tannins (which give softness to the tannins) was confirmed compared to the wine obtained from the control grapes where the concentrations of flavantriols (dry tannins) are higher, which express the immaturity of the seed of the grain, which gives the feeling of dry and astringent tannins.

Chemical analyses performed on wines obtained from treated and control grapes showed no significant differences in terms of parameters such as: alcohol, total acids, pH, total extract, and volatile acids.

According to the analysis of the sensory (descriptive) characteristics of the wines obtained from the treated grapes and the control, significant differences are observed in terms of taste and aroma descriptors. The wine made from the treated grapes is characterized by pronounced fruitiness and harmony, softness and fullness in the taste compared to the control wine, which is characterized by greater bitterness (astringency), vegetality and tartness in the taste.

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