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Investigating the Impact of Yeasts Additives on the Quality of the Red Wines: Autolyzes of Yeast and Yeast Derivatives Introduced During Alcoholic Fermentation

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ABSTRACT

The second part of the article series is about the study of the influence of yeast and autolyzed yeast derivative on red wines' qualitative and quantitative characteristics. Wine samples in which the preparation process was explained in the first part of the article were investigated. Wine coloring and phenolic compounds were measured. Organoleptic properties of the wines are presented as spider graphs with tasting notes.

Introduction

One of the main quality parameters of red wine is color and phenolic compounds. As mentioned in the study's first article (Kazumyan and Mikaelyan, 2022), Armenian grape varieties have been chosen: Tigrani, Karmrahyut, and Charentsi which are selective grapes with red-colored pulp (juice). These grape verities have been slightly investigated and our research will be useful for many Armenian winemaking companies. Winemakers use these verities to enhance the color and taste of red wines. Many winemaking companies refuse to use the Karmratut grape because it has unstable color and coloring matter sediment. Phenolic compounds in red wines also influence the wines' quality, color stability, and aging potential.

Materials and methods

The OIV and EAEU GOST methods were used to assess wine physicochemical indicators. Phenolic compounds are measured using the photocolorimetry method (Fracassetti and Gabrielli, 2017; Anikina, 2019; Gerzhikova, 2009; Jacobson, 2006; Ljiljana, 2016; Marnie, 2013; Moreno, 2012).

Armenian wine industry experts at the EVN Yerevan Wine Academy at Armenian National Agrarian University evaluated the organoleptic characteristics of the wines at the tasting room of the EVN Yerevan Wine Academy in collaboration with www.winenet.am/en/, the online resource.

Results and discussion

The corresponding spider diagrams (Aroma wheels) were drawn up based on the tasting results. The sensory analysis of wine quality involves assessing how the wine tastes, smells and looks (Marnie, 2013). The fermentation and aging processes first determine a wine's physicochemical composition. According to the matrix principle, sensory evaluation was conducted to determine the relationship between organoleptic assessment and physicochemical indicators of young wine composition. A total of 11 indicators were used to assess aroma perception, five indicators to assess taste perception, and four indicators to assess general perception. Based on all the information obtained, the spider graph of the wine-tasting matrix reflects the aroma wheels (Figure 1 and Table 1). It can be seen that Karmrahyut wine has the strongest flower smell at 3.2, Tigrani wine has the strongest smell of red and black fruits inherent in red wines in general, Karmrahyut wine has a spicy smell at 2,3, yeast smell is about the same as 1.7-1.8; the oak smell is lower in Karmrahyut wine, at 1.4.

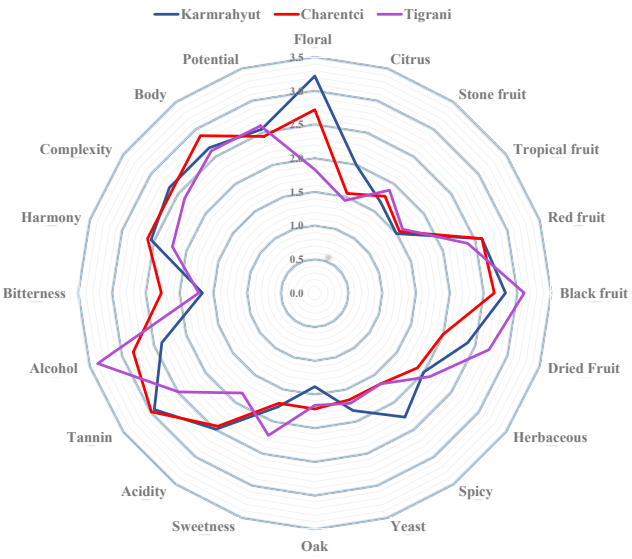

Figure 1. An aroma wheel and tasting graph for wines made from Tigrani, Karmrahyut, and Charentsi grape varieties (*composed by the authors*).

The characteristic of taste according to the results of tasting is distributed sweet, most pronounced in Tigrani wine – 2.2. The yeast race used has the property of increased accumulation of glycerol (up to 8 g/l); acidic taste prevails in Karmrahyut and Charentsi wines – 2.5-2.4; tannin taste is expressed in all samples and prevails in Charentsi wine 3.0 (Vidal et al., 2004); the taste of alcohol is expressed in Tigrani wine – 3.4; the taste of bitterness manifests itself in Charentsi wine – 2.3.

The general impression of the harmony taste, according to the characteristics of Tigrani (2.2) is noted below; against 2.6 in Karmrahyut and Charentsi wines, in terms of complexity the Tigrani is inferior to 2.4; in Karmrahyut and Charentsi, respectively 2.7 and 2.6.

Table 1. The wine-tasting results are drawn from Tigrani, Karmrahyut and Charentsi grapes*

Odour							
	Karmrahyut	**Charentsi**	**Tigrani**		**Karmrahyut**	**Charentsi**	**Tigrani**
Floral	3.2	2.7	1.8	Dried Fruit	2.4	2.0	2.7
Citrus	2.0	1.6	1.4	Herbaceous	2.0	1.9	2.1
Stone fruit	1.7	1.8	1.9	Spicy	2.3	1.7	1.7
Tropical fruit	1.5	1.6	1.6	Yeast	1.8	1.7	1.7
Red fruit	2.6	2.6	2.4	Oak	1.4	1.7	1.7
Black fruit	2.8	2.7	3.1				
Taste				**Overall Impression**			
Sweetness	1.8	1.7	2.2	Harmony	2.6	2.6	2.2
Acidity	2.5	2.4	1.8	Complexity	2.7	2.6	2.4
Tannin	2.9	3.0	2.5	Body	2.7	2.9	2.6
Alcohol	2.4	2.8	3.4	Potential	2.6	2.4	2.6
Bitterness	1.7	2.3	1.7	max = 5			

*Composed by the authors.

According to the characteristics of the body of the wine, the prevailing wine sample is Charentsi 2.9. The development potential is estimated at 2.6 for Tigrani and Karmrahyut wines and 2.4 for Charentsi wine.

Phenolic compounds play a significant role in plant metabolism. Grapes and wine contain phenolic compounds and their balanced complex determines red wine quality. Grape compounds, especially flavonoids, are significant in high-quality red wines. Flavonoids are mainly concentrated in the solid parts of the grape (Ribereau-Gayon, et al., 2006; Ribereau-Gayon, et al., 2006).

Processing of grapes and the subsequent alcoholic fermentation: after maceration of the grape pomace, the must is enriched with these valuable substances from the solid parts of the grape. According to the degree of oxidation, flavonoids are divided into groups. The mutual transformation of one group into another is possible through oxidation and reduction processes.

Tannins or proanthocyanidins (polymers of flavan-3-ol) are the most common phenols in grapes. Red wines are astringent due to tannins extracted from the skin and the soft parenchyma of the seed (Vidal, 2004; Yakimchenko, 2012). The diffusion coefficient, i.e. the rate at which tannin is extracted into fermenting must, depends on the size of the tannin molecule. Grapes contain monomers, dimers, trimers, oligomers, and polymers. The degree of polymerization reaches significant levels, and the molecular weight is up to 3500. These are catechin (condensed) tannins. Seed tannins consist of catechin and epicatechin. The degree of their polymerization is 10 units. Tannins from skins and seeds are extracted at different speeds. Extraction from the seeds is more intensive, easier, and in greater quantities than from the skins (Ribereau-Gayon, 2006). During alcoholic fermentation, tannin accumulation peaks on the 7-10th day (Kazumov, 2013). Tannins are easily dissolved in alcohol. Therefore, during alcoholic fermentation with the accumulation of ethyl alcohol, the dissolving ability must increase tannins (Yanniotis, 2007). After fermentation of sugars and enzymatic transformations, tannins polymerize, yielding macromolecules of proteins and polysaccharides. This forms complex compounds that become colloidal and precipitate. The tannins of grape skin and seeds have different effects on the wine taste (Busse-Valverde, 2011). Seed tannins define the wine's structure and body, while skin tannins make the wine soft and smooth (Marnie, 2013).

Catechins, tannins, and anthocyanins are the most concentrated natural antioxidants (Maleti, 2009). Tannins are the first oxidized substance of wine. Other compounds also can be involved in oxidative reactions (Mazza, 1995; Vidal, 2004; Yakimchenko, 2012).

Table 2. Tigrani, Karmrahyut, and Charentsi wine phenolic compounds and color composition*

№	Phenolic compounds				
	Parameters	**unit**	**Charentsi**	**Karmrahyut**	**Tigrani**
3.1.	Total Flavonoids	mg/l	2263.96	2261.88	1569.72
3.2.	Total anthocyanins	mg/l	368.73	508.45	658.30
3.3.	Total phenols (Gallic acid)	mg/l	2808.93	2740.71	2019.54
3.4.	Folin-Cicalteu Index		64	62	46
4.	Chromatic characteristics				
4.1.	A-420		0.37	0.35	0.45
4.2.	A-520		0.42	0.45	0.57
4.3.	A-620		0.11	0.12	0.19
4.4.	Color Intensity		8.96	9.17	12.19
4.5.	Color Shade		0.88	0.77	0.79
4.6.	Color composition, %				
4.6.1.	A-420 yellow	%	41.22	37.76	37.17
4.6.2.	A-520 red	%	46.79	49.00	46.99
4.6.3.	A-620 blue	%	13.63	15.25	18.82

*Composed by the authors.

Using the results of our tests shown in (Table 2), we determined the total amount of anthocyanins, flavonoids, and phenolic compounds in wine. These compounds are significant for evaluating tannin-anthocyanin reserves to prepare high-quality red wines.

The total amount of phenolic compounds is in the range of 2019.54 mg/l in Tigrani (the minimum amount), in Karmrahyut: 2740.71 mg/l, in Charentsi: 2808.93 mg/l (maximum amount). Total flavonoids – condensed phenolic substances recorded in samples: Tigrani – 1569.72 mg/l or 77.73 % (of the content); Karmrahyut – 2261.88 mg/l or 82.53 %; Charentsi – 2263.96 mg/l or 80.6%. Folin & Ciocalteu′s is an international index of total phenolic compound content in wines (International Organisation of Vine and Wine, 2021). The index is for Charentsi – 64, the highest and Tigrani – 46, the smallest.

A grape's anthocyanins determine the color of its future wine (Monagas, M. 2009; Wrolstad, 2005; Burns, 2002). Winemaking using the red method extracts the maximum amount of color pigments from the grape skin during the maceration process in the ongoing alcoholic fermentation and their subsequent preservation in wine (Ribereau-Gayon, 2006). Anthocyanins are polyphenols present in grapes and wine in the form of glycosides and diglycosides. Depending on the grape variety, the anthocyanin composition and total amount in wine differ. The total amount of anthocyanins was recorded as 368.73 mg/l in Charentsi, the lowest amount, 508.45 mg/l in Karmrahyut, and 658.30 mg/l in Tigrani, the highest.

Grapes contain anthocyanins, which cause wine's red color. Additionally, they are found in the thick epidermal layer of the skin. They absorb light and represent many colors ranging from red to blue (Anikina, 2012; Ribereau-Gayon, 2006). The color of young wine obtained through maceration depends on the minerals present in the wort. Anthocyanins (anthocyanidins) are associated with sugar molecules. Externally, anthocyanins are free in grapes and wine and can be linked by ester bonds with acetic and coumaric acids, with substituted hydroxyl and individual groups. The color and shade of anthocyanins are determined by their qualitative and quantitative states. The color composition in the samples was determined on a UNICO 2802 UV/VIS photoelectric colorimeter at 420, 520, and 620 nm, in a 1 mm thick cuvette (International Organisation of Vine and Wine, 2021; Heredia, 1998). As a result of the research, color intensity was obtained: the largest in Tigrani – 12.19; Karmrahyut – 9.17; the smallest in Charentsi – 8.96.

The highest color shade indicator was recorded in the Charentsi sample – 0.88, and in the Karmrahyut and Tigrani samples, respectively – 0.77 and 0.79.

There are three colors in the color composition, each determined by wavelengths of 420 nm (yellow), 520 nm (red), and 620 nm (blue). With over 65 % of the samples being red and blue, the Tigrani sample has the highest combination of these colors. As a result, the color intensity index is 12.19.

Conclusion

Based on the results of this study, we can conclude that the selected active dry yeast and yeast derivatives are beneficial for the production of red wine. Wines made from investigated grapes meet all quality requirements. Based on the tasting results, all wines display a body, typically red and black fruit aromas.

While the wine samples are in their middle stage of complexity and harmony, they were bottled in the spring of 2021 without being seasoned. The wine samples have excellent anthocyanins and the phenolic content is high. The highest total anthocyanins content was found in the Tigrani wine sample and the greatest total phenols were found in the Charenci wine sample.

About 50 % of the total wine color was determined in the Karmrahut wine sample. The aging potential of red wine is crucial for evaluating it. For reliable and valid research findings, this aspect must be assessed accurately, as well as yeast derivatives should be considered. Following a substantial period of bottle maturation, we plan to perform an aging potential analysis. Typically, this process takes several years.

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