Comparative analysis of the composition of Bayan Shirey, Rkatsiteli and Cabernet Sauvignon grape varieties for production of brandy wine materials

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Abstract

Abstract. This study aimed to investigate the chemical compositions of different grape varieties used for production of brandy wine materials.

Materials and Methods. It were studied white technical grape varieties (Bayan Shirey and Rkatsiteli), widely distributed in the country's wineries, as well as Cabernet Sauvignon, a red technical grape variety recently introduced to the Ganja-Gazakh region of the Republic of Azerbaijan. Titratable acidity, contents of sugar, phenolic compounds, pectin substances, and vitamin C were determined using standard methods.

Results and Discussion. The yield of unclarified juice was 78.68% from the Bayan Shirey, 74.34% from Rkatsiteli, and 66.35% from Cabernet Sauvignon grape varieties. The low juice yield of Cabernet Sauvignon is due to its relatively dense skin, and higher number and mass of seeds in the berry. The Bayan Shirey variety has a high yield of unclarified juice, which makes it promising for the production of brandy wine material. The total sugar content in the ripe grape variety Bayan Shirey, grown in the Samukh and Goygol districts, was 18.7 and 17.8%; for Rkatsiteli this indicator was 21.6 and 19.3%, and for the Cabernet-Sauvignon variety, it was 22.1 and 19.4%, respectively. The active acidity of ripe grape varieties varied between 3.2 and 3.3. Active acidity changed between 3.8 and 4.1 in unripe and overripe grape varieties.

The content of phenolic compounds in ripe varieties of grapes was between 0.74 and 1.20 g/100 ml. Among studied variants, ripe grape varieties were the richest in phenolic compounds. Pectic substances in ripe varieties of grapes varied between 0.23 and 0.52 g/100 ml. Fully ripe grape varieties were richer in vitamin C than unripe and overripe varieties. The content of vitamin C in ripe varieties of grapes varied between 7.8 and 12.4 mg/l.

The research has revealed that the most suitable varieties for the production of brandy wine materials are Bayan Shirey and Rkatsiteli.

Conclusions. The results of the study showed that ripe grape varieties such as Bayan Shirey, Rkatsiteli, and Cabernet Sauvignon have the best chemical composition for the production of brandy wine materials, including high content of sugar, phenolic compounds, and vitamin C.

Introduction

The quality of the wine material used for brandy production depends on the chemical composition of the original grapes. In recent decades, there has been a growing interest in studying the chemical characteristics of grapes, since parameters such as acidity, amounts of sugar, phenolic compounds, anthocyanins, and pectic substances significantly affect the sensory properties of the final product. It is essential to understand how different grape varieties, including white and red technical ones, interact with the terroir and technological processes that allow achieving the desired balance of taste, aroma, and structure of the final liquor (Van Leeuwen et al., 2006).

In the wine industry, especially in the production of brandy wine material, the importance of choosing a grape variety with optimal chemical properties is increasing. However, in practice it is not always possible to determine exactly which grape varieties are most suitable for obtaining a quality product, especially given the different growing conditions and degree of ripeness of the fruit. In this regard, there is a need to conduct comparative studies of the chemical composition of different grape varieties and their impact on the quality of brandy wine material (Lončarić et al., 2022).

The study of the chemical characteristics of grapes is of key importance for the wine industry, especially in the context of the production of brandy wine materials. In recent decades, there has been an active interest in the chemical composition of various grape varieties, since it directly affects the sensory characteristics of the final product. Parameters such as acidity, levels of sugar, phenolic, and anthocyanins vary significantly depending on the variety, terroir, and growing conditions (Dimitrov et al., 2016; Louw and Lambrechts, 2012; Ranković et al., 2004).

To produce high-quality brandy, it is necessary first to prepare high-quality brandy wine material that meets modern requirements for sensory and chemical characteristics and provide a rich taste, aroma, and stability of the product. When producing brandy wine material, it is necessary to pay special attention to the grape varieties, their degree of maturity, richness in chemical components, and other factors (Dhiman et al., 2011).

Despite extensive research, many aspects of the chemical composition of grapes remain insufficiently studied. The aim of this study was to investigate the chemical characteristics of individual grape varieties used for the production of brandy wine materials to identify patterns that may be useful for optimizing the production process.

The goal of the study was to analyze the composition of the red grape variety Cabernet-Sauvignon and the white grape varieties Bayan Shirey and Rkatsiteli to determine their potential for the production of high-quality brandy wine materials.

Materials and methods

The objects of the research were white technical grape varieties Bayan Shirey and Rkatsiteli, as well as the red technical grape variety Cabernet-Sauvignon, grown in Ganja-Gazakh, Samukh, and Goygol districts of Azerbaijan.

Bayan Shirey. The homeland of this white technical variety is Azerbaijan, where it has been widely distributed thanks to adaptation to local conditions. The grape variety Bayan Shirey is more widespread in Uzbekistan, Turkmenistan, Kazakhstan, Tajikistan, Ukraine, Moldova, and other countries. It is successfully cultivated and used in winemaking. Its aroma is light and fruity, with a hint of citrus, the sugar level is 16-20%, and the acidity is 5.5–8 g/l. It belongs to varieties of the late ripening period.

Rkatsiteli. The homeland of this grape variety is Kakheti, Georgia. In Azerbaijan, most of Rkatsiteli grows in the Goygol and Samukh districts. Grape varieties grown in the foothills are more prone to sugar accumulation than those grown in flat areas are. Currently, in addition to table and brandy wine material, other varieties of fortified wines are also produced from the Rkatsiteli grape variety. This variety belongs to the mid-late ripening period. In a fully ripe Rkatsiteli variety, the sugar content reaches 18-24%, titratable acidity is 5.5–6.5 g/l. Rkatsiteli has good resistance to grape diseases.

Cabernet Sauvignon is a red technical grape variety that first appeared in the 17th century in Bordeaux, France. The Cabernet Sauvignon grape variety, bred in the late 19th – early 20th century, was planted in Azerbaijan in the collections of research institutions, and on the farms of Karabakh, Shirvan, and the Ganja-Gazakh regions. Currently, this variety is more common in the wineries of the Goygol and Samukh districts.

Research methods

Mechanical composition of grape varieties

When studying the mechanical composition of grape varieties, indicators such as the average cluster mass, the mass of the skin and the comb, the mass and number of berries, the mass of seeds and pulp were determined.

The percentage ratio of each component in relation to the total mass of the cluster was calculated using the formula

$$\% = \frac{component\ mass}{total\ \ mass\ of\ cluster} \times 100$$

Determination of sugar content

Grape samples were crushed and squeezed to determine the total sugar content. The resulting juice was filtered to remove pulp and sediment. Then, 1 ml of an invertase enzyme solution was added to 10 ml of the filtrate, which broke down sucrose into glucose and fructose. After 30 minutes at 37 °C, the glucose concentration was determined using glucose oxidase enzyme (Al-Mhanna et al., 2018).

Determination of titratable acidity

A titrimetric method was used to determine acidity. The content of titratable acids in grape juice was measured using a 0.1 N sodium hydroxide (NaOH) solution until a neutral reaction was achieved (pH 7.0) (Gąstoł, 2015). Titratable acidity was expressed as grams of tartaric acid per liter.

Determination of active acidity

Active acidity was measured using a pH meter.

Determination of vitamin C

The vitamin C content was determined by titration using 2,6-dichlorophenolindophenol. The grape was squeezed and filtered. A few drops of indicator were added to 10 ml of the filtrate and then titrated with a 0.1% solution of 2,6-dichlorophenolindophenol until the color changed to pink. The concentration of vitamin C was calculated based on the expense of the titrant and expressed in milligrams per 100 ml of juice (Chang et al., 2016).

Determination of the content of pectic substances

The method for measurement of the content of pectic substances in grapes is based on the extraction and transfer of pectin to the dissolved state. Grapes are carefully squeezed to obtain juice. The resulting juice is filtered to remove pulp and sediment. For the extraction of pectic substances, a 0.1 N solution of hydrochloric acid is used. The samples are kept at a temperature of 80 °C for 30 minutes. Then, the extract is cooled and filtered. 1 ml of carbazole reagent (0.1% solution of carbazole in 95% ethanol) and 1 ml of concentrated sulfuric acid are added to 1 ml of the obtained extract. The resulting mixture is carefully mixed and kept in a water bath at a temperature of 60 °C for 10–15 minutes. Then the mixture is cooled at room temperature and the volume is brought up to 10 ml with distilled water. The optical density of the obtained solution is measured on a spectrophotometer at a wavelength of 520 nm. The concentration of pectic substances (including pectin and protopectin) is calculated according to a standard curve constructed based on a known concentration of a pectin standard (for example, apple pectin).

Determination of the content of phenolic compounds

The determination of the content of phenolic compounds was carried out using the Folin–Ciocalteu assay, which allows for the quantitative estimation of the content of phenols in wine samples (Kupina, 2019).

The method is based on oxidation-reduction reactions with the use of phosphorus-vanadate reagent (Folin–Ciocalteu reagent), which is reduced in the presence of phenols. This leads to a change in the color of the solution, and the intensity of the color can be used to judge the content of phenols. The wine is subjected to preliminary extraction in order to remove solid particles and other substances that may interfere with the reaction. In some cases, additional filtration is carried out. A solution of Folin–Ciocalteu reagent is added to the purified wine sample, which is a mixture of molybdate and vanadate. This reagent interacts with phenolic groups in wine. Then a solution of sodium carbonate (Na_2CO_3) was added to provide an alkaline medium necessary for the reaction. Phenols reduce molybdenum and vanadium, which causes a change in the color of the solution, usually to blue-green. The solution is incubated at room temperature or in a water bath for 30 minutes. After incubation, the optical density (or absorption) of the solution was measured at a wavelength of 760 nm, since the color change is proportional to the amounts of phenolic compounds.

For accurate estimation of the content of phenols, a calibration curve is constructed using a standard solution of phenolic compounds, for example, gallic acid. Based on this curve, the content of phenols in the sample is determined.

The content of phenols in wine was calculated using the established dependence between absorption and concentration of phenols in a standard solution.

Assessing the ripeness of grapes

The grapes were collected from different parts of the vineyard to ensure the representativeness of sampling. Only healthy berries were accepted, excluding damaged ones. The berries were divided into three categories: unripe, ripe, and overripe. Before conducting chemical analyses, the berries were thoroughly washed and processed, after which they were crushed and juice was extracted.

Grape ripeness was determined by measuring sugar content and titratable acidity. Sugar content was measured using a refractometer, which provides a Brix reading, where 1°Brix is equivalent to 1 gram of sugar per 100 g of the solution (1°Brix = 1% sugar) (Jaywant et al., 2022; Reid, 2002). The ripeness of grapes was characterized by a soluble solid content of about 20°Brix and a titratable acidity value of 6–8 g/l (Lago et al., 2017). For the ripe Bayan Shirey and Rkatsiteli white varieties, sugar content varied between 17.8 and 21.6% and for the red Cabernet-Sauvignon variety – between 19.4 and 22.1%.

In white varieties of ripe grapes (Bayan Shirey and Rkatsiteli), the acidity varied between 6.7 and 7.8 g/l, for the red variety (Cabernet Sauvignon) – between 6.5 and 6.7 g/l. For a more accurate assessment of the stage of physiological maturity, the glucoacidometric method was used, which involves calculating the ratio of sugar content (in Brix) to titratable acidity. According to literary data, the optimal value of this ratio is considered to be between 2.5 and 3.5 (Lago et al., 2017). For Bayan Shirey and Rkatsiteli, it was 2.65–2.77 and for Cabernet Sauvignon it was 2.98–3.3.

Visual and organoleptic (taste) assessments were also carried out to assess the ripeness of the grapes. At this stage of the study, attention was paid to the condition of the berries (color, consistency, presence of aromas) and their taste qualities (sweetness, aroma, texture). All ripe berries were distinguished by a uniform color: Bayan Shirey had a golden-yellow color; Cabernet-Sauvignon had a dark red color, sweet taste, and a pronounced aroma, which also confirmed their ripeness.

Statistical analysis

The chemical parameters were determined in five replicates. The results are presented as mean ± standard deviation.

Results and discussion

Mechanical composition of grape varieties

The mechanical composition of white technical grape varieties Bayan Shirey and Rkatsiteli, and red technical grape variety Cabernet Sauvignon were studied. The mechanical composition of grapes includes grape skins and combs. A grape cluster consists of a comb, berries, skins, pulp, seeds, and juice (Reid, 2002). Depending on the degree of maturity of the grapes, growing conditions, environmental situation, and applied agrotechnical conditions, the components included in the mechanical composition changed differently in percentage terms.

The mechanical composition of the studied grape varieties is presented in Tables 1 and 2.

The mass of clusters and the number of berries were determined for three grape varieties grown under the conditions of the Goygol district: Bayan Shirey, Rkatsiteli, and Cabernet Sauvignon. The data presented in Table 1 show that the average mass of berries and the total number of berries in clusters vary significantly.

Table 1

Mechanical composition of technical grape varieties grown in Goygol district

Indicators	Grape varieties		
	Bayan Shirey	**Rkatsiteli**	**Cabernet Sauvignon**
Average mass of a grape cluster, g	194.98±0.02	152.50±0.01	132.70±0.01
Number of berries per cluster, g	94.00±0.04	87.00±0.03	65.00±0.01
Mass of grape comb per cluster, g	6.84±0.01	7.00±0.02	7.20±0.01
Mass of grapes per cluster, g	188.14±0.02	145.50±0.01	125.50±0.01
Mass of grape skin per cluster, g	6.08±0.01	7.40±0.00	7.40±0.01
Mass of grape seed per cluster, g	3.68±0.01	4.15±0.01	8.30±0.01
Mass of grape pulp per cluster, g	24.96±0.05	20.52±0.01	16.40±0.01
Percentage of the total mass of a grape cluster			
Comb	3.51±0.01	4.59±0.02	5.42±0.02
Skin	3.12±0.02	4.85±0.03	5.58±0.01
Seeds	1.89±0.03	2.72±0.01	6.25±0.01
Pulp	12.80±0.01	13.50±0.03	20.15±0.01
Juice with pulp	91.48±0.03	87.84±0.02	82.75±0.01
Unclarified juice without pulp	78.68±0.01	74.34±0.01	66.35±0.04

Table 2

Mechanical composition of technical grape varieties grown in Samukh district

Indicators	Grape varieties		
	Bayan Shirey	**Rkatsiteli**	**Cabernet Sauvignon**
Average mass of a grape cluster, g	201.50±0.04	156.40±0.01	128.60±0.01
Number of berries per cluster, g	98.00±0.01	91.00±0.01	63.00±0.01
Mass of grape comb per cluster, g	6.40±0.03	6.70±0.02	7.40±0.01
Mass of grapes per cluster, g	195.10±0.02	149.70±0.01	121.20±0.03
Mass of grape skin per cluster, g	6.48±0.01	7.80±0.02	7.60±0.01
Mass of grape seed per cluster, g	4.05±0.01	4.55±0.03	8.80±0.02
Mass of grape pulp per cluster, g	25.20±0.01	19.70±0.02	20.85±0.03
Percentage of the total mass of a grape cluster			
Comb	3.18±0.01	4.28±0.03	5.75±0.01
Skin	3.21±0.03	4.98±0.01	5.91±0.02
Seeds	2.01±0.01	2.91±0.02	6.84±0.01
Pulp	12.50±0.01	12.60±0.02	16.20±0.01
Juice with pulp	91.60±0.03	87.82±0.02	81.50±0.01
Unclarified juice without pulp	79.10±0.01	75.22±0.01	65.30±0.02

The Bayan Shirey variety had the highest average berry mass (188.14 g) and the highest number of berries in clusters (94.0). This may indicate a high yield potential for this variety, which is a positive aspect for winegrowers and winemakers. Larger and more numerous berries can result in a higher juice yield and, ultimately, better wine quality. The Rkatsiteli variety, with a smaller average berry mass (145.5 g) and berry quantity (87.0), is inferior to Bayan Shirey in these indicators but remains competitive. Cabernet Sauvignon showed the lowest values: 125.5 g on average and only 65.0 berries per cluster. This can be considered a disadvantage in terms of yield. However, Cabernet Sauvignon is known for its high-quality characteristics and potential for creating complex wines.

A comparative analysis of grape varieties established the yield of unclarified juice. The Bayan Shirey grape variety had a yield of unclarified juice of 78.68%, Rkatsiteli – 74.34%, and Cabernet Sauvignon – 66.35%. The low juice yield of Cabernet Sauvignon is attributed to its relatively dense skin and higher number and mass of seeds in the berry.

Table 2 shows significant changes in the mechanical composition of grape varieties grown in the Samukh district. Depending on the variety, the mass of the grape cluster, the number and mass of berries, the yield of the comb and pulp differ. In the Samukh district, the mass of the cluster of the Bayan Shirey grape variety averaged 201.5 g, for the Rkatsiteli grape variety, this value was 156.4 g; while for the Cabernet Sauvignon variety, it was 128.6 g. The research revealed that the number of berries in different grape varieties also varied. Bayan Shirey significantly exceeded Rkatsiteli and Cabernet Sauvignon in cluster mass and number of berries. This could be seen as a positive result, as larger clusters could indicate higher yields (Reid, 2002).

Higher yields may contribute to the economic viability of wineries. Differences in stem mass may indicate different growth and development patterns of varieties (Reid, 2002). The higher stem mass of Cabernet Sauvignon may indicate a more robust structure, but this may also increase the amount of waste during processing. The lower skin mass of Bayan Shirey may be beneficial for wine production, as it may indicate less astringency and a sweeter taste.

According to Fataliyev (2012), varieties such as Chardonnay and Merlot also show similar patterns in mechanical composition. For example, Chardonnay has a large cluster mass and high yield, which makes it one of the most popular varieties in the world. Merlot, like Cabernet Sauvignon, has a high content of phenolic compounds, which affects its aroma and taste.

The results of the study show that the Bayan Shirey variety has advantages in terms of yield and cluster mass, which makes it more attractive for wineries. The Bayan Shirey grape variety had a seed mass of 4.05 g and a pulp mass of 25.2 g; the Rkatsiteli variety had a seed mass of 4.55 g and a pulp mass of 19.70 g; and the Cabernet Sauvignon variety had a seed mass of 8.8 g and a pulp mass of 20.85 g. The ratio of the yield of combs, skins, seeds, and pulp to the total mass of the grape cluster was also determined. Depending on the variety of grape, the comb makes up 2.5–6%, the skin 7–8%, the seeds 3–4% and the pulp with juice 80–92% (Salimov, 2022). The same grape variety grows in different districts, though their mechanical composition differs from each other.

The yield of unclarified juice varied depending on the districts and the variety. The Bayan Shirey grape variety grown in the Goygol district had a yield of unclarified juice of 78.68%, while in the Samukh district, the yield of unclarified juice obtained from the same variety was 79.1%.

Temperature, humidity, and rainfall can significantly affect the sugar and acid content of grapes, which in turn changes juice yield (Gąstoł, 2015). Different soil types can contain different levels of nutrients stipulating the growth and development of grapevines. The methods of harvesting, processing, and squeezing grapes can vary between districts and significantly affect the amount of juice obtained. Growing conditions and vineyard health (e.g. the presence of diseases or pests) can also influence juice yield. Thus, the yield of unclarified juice depends on many factors, and differences between grapes grown in different districts can be attributed to a combination of them (Gąstoł, 2015).

The yield of unclarified juice of different grape varieties grown in the Goygol and Samukh districts is shown in Figure 1. As seen in the figure, in the Samukh district, the yield of unclarified juice of the Bayan Shirey and Rkatsiteli varieties was higher than that of the same varieties grown in the Goygol district.

The largest amount of unclarified juice was obtained from the Bayan Shirey and Rkatsiteli varieties. The smallest yield of unclarified juice was obtained from the Cabernet Sauvignon variety, grown in both districts.

The average cluster mass of grape varieties grown in the Goygol and Samukh districts is shown in Figure 2.

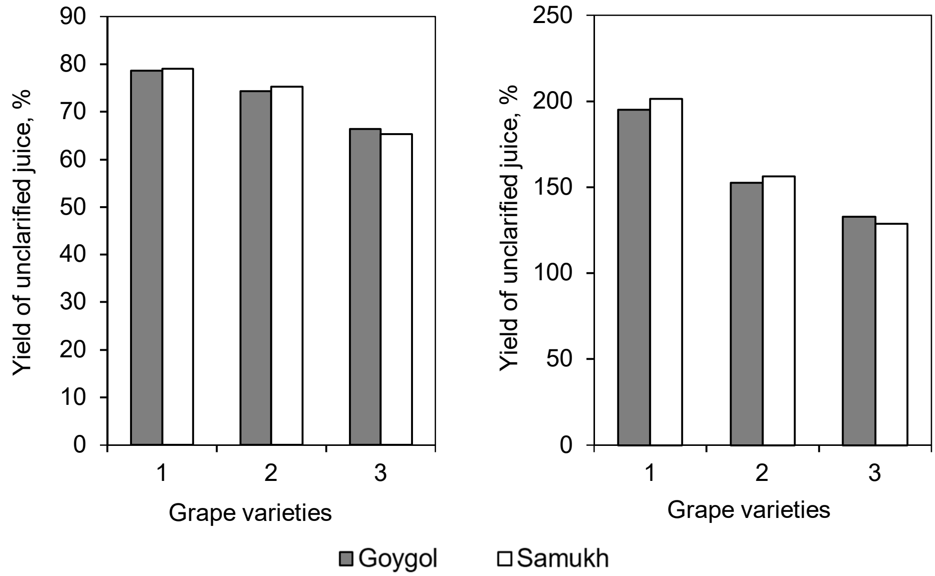

Figure 1. Yield of unclarified juice from grape varieties grown in Goygol and Samukh districts: 1 – Bayan Shirey, 2 – Rkatsiteli, 3 – Cabernet Sauvignon.

Figure 2. Average cluster mass of grape varieties grown in Goygol and Samukh districts, in grams: 1 – Bayan Shirey, 2 – Rkatsiteli, 3 – Cabernet Sauvignon.

The Bayan Shirey and Rkatsiteli grape varieties are more suitable for the production of brandy wine material than the Cabernet Sauvignon variety. Cabernet Sauvignon has a thicker skin and less water content in the berries and less juice is released when squeezing compared to Bayan Shirey and Rkatsiteli. A high juice yield is important for the production of brandy wine material, as this contributes to a greater amount of raw materials for fermentation and subsequent alcohol production. Bayan Shirey and Rkatsiteli have a higher sugar content and balanced acidity, which is important for further fermentation and distillation.

Since Cabernet Sauvignon is a red technical grape variety, it is recommended to use it for the production of other types of wine, mainly red table wines. From the above, it is clear that the quality of the produced brandy wine material largely depends on the mechanical composition of the grapes.

Chemical composition of grape varieties

Tables 3 and 4 present data on the quantitative change in some chemical indicators of grape varieties depending on the degree of ripeness.

Table 3

Changes in chemical composition of grape varieties grown in Samukh district depending on the degree of ripeness

Chemical indicators	Grape varieties								
	Bayan Shirey			Rkatsiteli			Cabernet Sauvignon		
	I	II	III	I	II	III	I	II	III
Total sugar, g/100 ml	18.70 ±0.02	16.50 ±0.04	17.80 ±0.01	21.60 ±0.03	18.20 ±0.05	19.40 ±0.02	22.10 ±0.04	18.60 ±0.01	19.40 ±0.03
Titratable acidity, g/100 ml	7.00 ±0.03	7.90 ±0.02	5.70 ±0.04	6.80 ±0.01	7.60 ±0.03	5.20 ±0.05	6.50 ±0.02	7.60 ±0.04	5.20 ±0.01
Active acidity, pH	3.20 ±0.04	3.80 ±0.01	3.90 ±0.02	3.30 ±0.04	3.90 ±0.01	4.00 ±0.03	3.30 ±0.05	4.00 ±0.02	4.10 ±0.03
Phenolic compounds, g/100 ml	0.78 ±0.02	0.70 ±0.03	0.54 ±0.04	0.74 ±0.02	0.65 ±0.04	0.50 ±0.01	1.05 ±0.03	0.95 ±0.05	0.68 ±0.03
Pectic ubstances, g/100 ml	0.25 ±0.05	0.31 ±0.03	0.18 ±0.04	0.23 ±0.01	0.28 ±0.02	0.20 ±0.04	0.50 ±0.01	0.62 ±0.03	0.36 ±0.05
Protopectin, g/100 ml	0.12 ±0.01	0.20 ±0.04	0.08 ±0.02	0.11 ±0.05	0.18 ±0.03	0.08 ±0.02	0.18 ±0.04	0.40 ±0.01	0.16 ±0.04
Pectin, g/100 ml	0.13 ±0.03	0.11 ±0.01	0.10 ±0.02	0.12 ±0.03	0.10 ±0.01	0.12 ±0.03	0.32 ±0.02	0.22 ±0.04	0.20 ±0.01
Vitamin C, mg/l	8.20 ±0.01	5.60 ±0.03	3.40 ±0.05	7.80 ±0.01	5.40 ±0.01	3.10 ±0.03	10.20 ±0.01	7.60 ±0.02	4.80 ±0.02

Note: I – Ripe grapes, II – Unripe grapes, III – Overripe grapes

Total sugar, which is the main indicator of grape quality, was the lowest in unripe grape varieties. The total sugar content in the unripe Bayan Shirey grape variety grown in the Samukh district was 16.5%, while in Rkatsiteli, this value was 18.2%, and in Cabernet Sauvignon, it was 18.6%. Depending on the degree of ripeness of grape varieties, the highest sugar content was observed in fully ripe varieties. Total or titratable acidity is important in the winemaking process. Organic acids of grapes are formed mainly because of the exchange of carbohydrates, amino acids, proteins, and other organic substances during photosynthesis.

The quality of grapes and wine largely depends on titratable acidity. Tartaric acid is the main titratable acidity of grapes (Baiano et al., 2012). Besides, grapes contain malic, succinic, citric, and other non-volatile acids (Nabiev and Moslemzade, 2008). The lowest titratable acidity was recorded in overripe grape varieties (Table 1). The acidity of the overripe Bayan Shirey grape variety was 5.7 g/l, while for the Rkatsiteli and Cabernet Sauvignon varieties, this value was 5.2 g/l. The low titratable acidity of overripe grape varieties compared to other variants is explained by the fact that, like other nutrients, it is spent on the respiratory process (Baiano et al., 2012).

Exceeding the titratable acidity of grapes is inappropriate. Mostly unripe grape varieties have high titratable acidity (Baiano et al., 2012). It is also known that unripe grapes contain large amounts of malic acid. Brandy and table wines made from unripe grapes have an unpleasant, harsh taste due to the high level of malic acid (more than 2 g/l), called green acidity (Nabiev, 2010). Increased green acidity in wine creates conditions for the formation of various defects, including mousy taste, during the storage period of wine (Baiano et al., 2012). Therefore, to produce high-quality wines, including brandy, it is necessary to regulate the amount of titratable acidity of grapes.

Active acidity affects the quality of wine (Vicente et al., 2022). It directly affects the balance of taste, aroma, and stability of wine. While high acidity helps to preserve freshness and balance, high acidity can give the wine harshness and unpleasant sensations.

When making brandy wine material, it is important that the acidity maintain the taste without excessive harshness, ensuring the purity and complexity of the aroma. The correct level of acidity also contributes to better preservation of wine and prevents the development of unwanted defects during storage. High active acidity in grape juice and wine is undesirable because it can impart a harsh and unpleasant taste, interfering with the harmony of the overall profile of the drink. It can also hinder the balanced development of aroma and taste, making the wine less enjoyable to drink. In addition, excessive acidity can negatively affect the fermentation process and storage, increasing the risk of developing defects and reducing the stability of the wine (Fataliyev, 2012).

The change in pH depends on the grape variety, soil and climate conditions and other factors. When the pH is between 3.0 and 3.3, the active acidity of the environment or wine slows down oxidation and reduction processes. Therefore, the stability, transparency, color preservation, and other factors of wine largely depend on active acidity. As seen in Table 3, fully ripe grape varieties have normalized active acidity for wine production. Active acidity in fully ripe grape varieties changed between 3.2 and 3.3. In unripe and overripe grape varieties, active acidity varied within the range of pH values of 3.8-4.1. Fully ripe grape varieties are considered more optimal for wine production.

Phenolic compounds are widely distributed in plants, including grapes, and have important technological properties (Cosme et al., 2018). The quality of grapes and wine largely depends on phenolic compounds. The content of phenolic compounds in grape skins is higher than in juice and pulp (Bendaali et al., 2022). Some of the important biological and technological properties of phenolic substances are their antioxidant and antimicrobial propertiesGrape and wine varieties rich in phenolic substances are not only more resistant to diseases, but also rich in extractive substances (Nabiev and Moslemzade, 2008). As seen in Table 1, fully ripened grape varieties are richer in phenolic compounds compared to other varieties. The presence of phenolic compounds in grapes and wine stipulates their enrichment with aromatic substances.

The quality of the prepared brandy wine material also largely depends on pectic substances. The pectic substances are mainly represented by pectic acid, pectin, and protopectin. In addition, grapes, especially wine, contain pectin salts. These salts are mainly contained in grapes grown on soils rich in calcium and magnesium ions (Velioglu et al., 1998). According to their biological and technological properties, pectic substances are colloidal particles. The presence of pectic substances affects the yield of grape juice, and the transparency of juice and wine (Nabiev and Moslemzade, 2008). Therefore, the production of high-quality brandy wine materials largely depends on the content of pectic substances.

Table 4

Changes in chemical composition of grape varieties grown in Goygol district depending on the degree of ripeness

Chemical indicators	Grape varieties								
	Bayan Shirey			Rkatsiteli			Cabernet Sauvignon		
	I	II	I	I	I	III	I	II	I
Total sugar, g/100ml	17.80 ±0.01	16.10 ±0.03	17.20 ±0.05	19.30 ±0.02	17.40 ±0.03	18.20 ±0.01	19.40 ±0.03	17.60 ±0.04	18.50 ±0.02
Titratable acidity, g/100 ml	7.80 ±0.01	8.30 ±0.01	6.70 ±0.03	7.20 ±0.05	8.10 ±0.02	5.60 ±0.03	6.70 ±0.04	8.70 ±0.02	5.40 ±0.04
Active acidity, pH	3.30 ±0.01	4.0 ±0.04	4.20 ±0.01	3.20 ±0.03	3.90 ±0.05	4.10 ±0.03	3.20 ±0.02	3.60 ±0.04	3.90 ±0.02
Phenolic compounds, g/100 ml	0.82 ±0.03	0.74 ±0.02	0.58 ±0.05	0.80 ±0.01	0.74 ±0.03	0.55 ±0.02	1.20 ±0.04	1.02 ±0.01	0.70 ±0.04
Pectic substances, g/100 ml	0.28 ±0.01	0.34 ±0.04	0.23 ±0.03	0.25 ±0.02	0.32 ±0.01	0.21 ±0.03	0.52 ±0.04	0.64 ±0.05	0.40 ±0.02
Protopectin, g/100 ml	0.13 ±0.03	0.23 ±0.01	0.10 ±0.02	0.12 ±0.05	0.22 ±0.04	0.09 ±0.01	0.20 ±0.03	0.42 ±0.02	0.16 ±0.04
Pectin, g/100 ml	0.15 ±0.04	0.11 ±0.02	0.13 ±0.03	0.13 ±0.04	0.10 ±0.02	0.12 ±0.01	0.32 ±0.01	0.22 ±0.03	0.24 ±0.05
Vitamin C, mg/l	8.50 ±0.02	8.40 ±0.05	3.80 ±0.04	8.20 ±0.03	6.10 ±0.01	3.70 ±0.04	12.40 ±0.03	8.20 ±0.01	5.10 ±0.02

Note: I – Ripe grapes, II – Unripe grapes, III – Overripe grapes

Pectic substances, including protopectin, are mainly found in unripe grapes (Tables 2 and 3). For example, the content of pectic substances in unripe Rkatsiteli grapes grown in the Samukh district was 0.28 g/100 ml, while in ripe grapes, this parameter was 0.23 g/100 ml, and in overripe grapes, it was 0.20 g/100 ml.

The research revealed that the red grape variety is richer in pectic substances than the white grape variety. The total amount of pectic substances in the fully ripened Bayan Shirey grape variety grown under the conditions of the Goygol district was 0.28 g / 100 ml, while for the Rkatsiteli variety, this parameter was 0.25 g/100 ml, and for the Cabernet Sauvignon variety, it was 0.52 g/100 ml (Table 4).

The studies revealed that the unripe Rkatsiteli grape variety had a protopectin content of 0.18 g/100 ml, while the ripe variety had a protopectin content of 0.11 g/100 ml, and the overripe variety had a protopectin content of 0.08 g/100 ml (Table 3). As the grapes ripen, the amount of protopectin decreases and turns into pectin. The conversion of protopectin into pectin occurs under the action of the protopectinase enzyme. During this period, the grapes become relatively soft and are enriched with aromatic and other nutrients through the process of photosynthesis (Velioglu et al., 1998).

In wine materials, the content of protopectin above the norm is inappropriate, since protopectin is practically insoluble in water (Velioglu et al., 1998). This prevents the clarification and stability of the wine material. Therefore, when producing brandy, grape varieties should be selected so that the content of pectic substances, mainly protopectin, is lower. The amount of pectic substances in grapes depends to some extent on the specific characteristics of the variety, the degree of maturity, soil and climatic conditions, and other factors (Rouxinol et al., 2023). The amount of pectin varies among grape varieties. For example, varieties with high acidity levels often contain more pectin, which can affect the fermentation and clarification process. At the stage of full ripening, pectin levels usually decrease. Unripe berries contain more pectin, which can lead to problems with clarification (Velioglu et al., 1998).

The quantitative content of vitamin C was also determined depending on the degree of ripeness of the grape varieties. The red grape variety Cabernet Sauvignon is richer in vitamin C than white grape varieties. In fully ripened Cabernet Sauvignon grapes, the content of vitamin C varied between 10.2 and 12.4 mg/l. In the Rkatsiteli variety, this indicator varied between 7.8 and 8.2 mg/l, and in the Bayan Shirey variety, between 8.2 and 8.5 mg/l (Tables 3 and 4).

It is known that fully ripened grape varieties are richer in vitamin C than unripe and overripe grape varieties. As seen in Table 3, vitamin C in the fully ripened Bayan Shirey grape variety was 8.2 mg/l, in unripe grapes this parameter was 5.6 mg/l, and in overripe grapes – 3.4 mg/l. Therefore, when producing brandy wine material, it is recommended to use fully ripened grapes.

Conclusions

1. To produce high-quality brandy wine material, the mechanical composition of grape varieties used as raw materials, as well as the juice yield, was determined. The yield of unclarified juice with and without pulp obtained from technical grape varieties, Bayan Shirey, Rkatsiteli, and Cabernet Sauvignon, grown in the Goygol and Samukh districts varied depending on the variety and region.
2. A comparative analysis of grape varieties established the yield of unclarified juice. The Bayan Shirey grape variety had a 78.68% yield of unclarified juice, Rkatsiteli – 74.34%, and Cabernet Sauvignon – 66.35%. The low juice yield of Cabernet Sauvignon is due to its relatively dense skin, and higher number and mass of seeds in the berry. The Bayan Shirey variety has a high yield of unclarified juice, which makes it promising for the production of brandy wine material.
3. Depending on the degree of ripeness of grape varieties, the highest sugar content was found in fully ripe varieties. The active acidity of fully ripe grape varieties changed between 3.2 and 3.3. In unripe and overripe grape varieties, the active acidity varied between 3.8 and 4.1. It was found that fully ripe grape varieties compared to other varieties are richer in phenolic substances.
4. In unripe grape varieties, Bayan Shirey, Rkatsiteli, and Cabernet Sauvignon, grown under the conditions of the Samukh district, the content of pectic substances was 0.20, 0.18, and 0.40 g/100 ml. In ripened grapes, this indicator was 0.12, 0.11, and 0.18 g/100 ml, and in overripe grapes – 0.08, 0.08, and 0.16 g/100 ml, respectively. As the grapes ripened, the amount of protopectin decreased. In wine materials, the content of protopectin above the norm is inappropriate, since protopectin is practically insoluble in water and this prevents the clarification and stability of the wine material.
5. The research has revealed that the most suitable varieties for the production of brandy wine materials are Bayan Shirey and Rkatsiteli.

References

Al-Mhanna N.M., Huebner H., Buchholz R. (2018), Analysis of the sugar content in food products by using gas chromatography mass spectrometry and enzymatic methods, *Foods*, 7(11), 185, https://doi.org/10.3390/foods7110185

Baiano A., Terracone C., Peri G., Romaniello R. (2012), Application of hyperspectral imaging for prediction of physico-chemical and sensory characteristics of table grapes, *Computers and Electronics in Agriculture*, 87, pp. 142–151, https://doi.org/10.1016/j.compag.2012.06.002

Bendaali Y., Vaquero C., González C., Morata A. (2022), Elaboration of an organic beverage based on grape juice with positive nutritional properties, *Food Science and Nutrition*, 10(6), pp. 1768–1779, https://doi.org/10.1002/fsn3.2795

Chang S.K., Ismail A., Daud Z.A.M. (2016), Ascorbic acid: Properties, determination and uses, *Encyclopedia of Food and Health*, pp. 275–284. https://doi.org/10.1016/b978-0-12-384947-2.00044-1

Cosme F., Pinto T., Vilela A. (2018), Phenolic compounds and antioxidant activity in grape juices: A chemical and sensory view, *Beverages*, 4(1), 22, https//doi.org/10.3390/beverages4010022

Dhiman A.K., Attri S., Ramachandran P. (2011), Technology of brandy production, In: V.K. Joshi (Ed.), *Handbook of Enology: Principles, Practices and Recent Innovations*, *Volume 1, Introduction to Vine and Wine*, pp. 531–552.

Dimitrov D., Yoncheva T., Haygarov V. (2016), Evaluation the risk of toxic compounds formation in grape and fruit brandies, *Journal of Microbiology, Biotechnology and Food Sciences*, 6(1), pp. 681–684, https://doi.org/10.15414/jmbfs.2016.6.1.681-684

Fataliyev H.K. (2012), Practical course in winemaking, Baku.

Gąstoł M. (2015), Vineyard performance and fruit quality of some interspecific grapevine cultivars in cool climate conditions, *Folia Horticulturae*, 27, pp. 21–31, https://doi.org/10.1515/fhort-2015-0011

Jaywant S.A., Singh H., Arif K.M. (2022), Sensors and instruments for Brix measurement: A review, *Sensors (Basel)*, 22(6), 2290, https://doi.org/10.3390/s22062290

Kupina S., Fields C., Roman M.C., Brunelle Sh.L (2019), Determination of total phenolic content using the Folin-C assay, *Journal of AOAC International*, 102(1), pp. 320–321, https://doi.org/10.1093/jaoac/102.1.320

Lago L.O., Nicolli K.P., Marques A.B., Zini C.A., Welke J.E. (2017), Influence of ripeness and maceration of the grapes on levels of furan and carbonyl compounds in wine – Simultaneous quantitative determination and assessment of the exposure risk to these compounds, *Food Chemistry*, 230, pp. 594–603, https://doi.org/10.1016/j.foodchem.2017.03.090

Lončarić A., Patljak M., Blažević A., Jozinović A., Babić J., Šubarić D., Pichler A., Flanjak I., Kujundžić T., Miličević B. (2022), Changes in volatile compounds during grape brandy production from 'Cabernet Sauvignon' and 'Syrah' grape varieties, *Processes*, 10(5), 988, https://doi.org/10.3390/pr10050988

Louw L., Lambrechts M.G. (2012), Grape-based brandies: production, sensory properties and sensory evaluation, *Alcoholic Beverages*, pp. 281–298, https://doi.org/10.1533/9780857095176.3.281

Nabiev A.A. (2010), *Chemistry of Wine*, Elm, Baku.

Nabiev A.A., Moslemzade E.A. (2008). *Biochemistry of food products*, Elm, Baku.

Ranković V., Palić R.M., Živković J., Mošić I., Stanković S., Stojanović, G.S. (2004), Investigation of the impact of grape cultivars on the grape brandies quality, *Facta*

Universitatis – Series: Physics, Chemistry and Technology, 3, pp. 61–66, https://doi.org/10.2298/fupct0401061r

Reid M.S. (2002), Maturation and maturity indices, In: A.A. Kader (Ed.), *Postharvest Technology of Horticultural Crops*, University of California, San Diego, pp. 55–62.

Rouxinol M.I., Martins M.R., Barroso J.M., Rato A.E. (2023), Wine grapes ripening: A review on climate effect and analytical approach to increase wine quality, *Applied Biosciences*, 2(3), pp. 347-372, https://doi.org/10.3390/applbiosci2030023

Salimov V. (2022), Examination of variability in morphological and biological characteristics of some grape varieties of Azerbaijan, *Viticulture Studies*, 2(2), pp. 81–93, https://doi.org/10.52001/vis.2022.13.81.93

Van Leeuwen C., Seguin G. (2006), The concept of terroir in viticulture, *Journal of Wine Research*, 17(1), pp. 1–10, https://doi.org/10.1080/09571260600633135

Velioglu Y.S., Mazza G., Gao L., Qomah B.D. (1998), Antioxidant activity and total phenolics in selected fruits, vegetables and grain prod, *Journal of Agricultural and Food Chemistry*, 46(10), pp. 4113–4117, https://doi.org/10.1021/jf9801973

Vicente J., Baran Y., Navascués E., Santos A., Calderón F., Marquina D., Rauhut D., Benito S. (2022), Biological management of acidity in wine industry: A review, *International Journal of Food Microbiology*, 375, 109726, https://doi.org/10.1016/j.ijfoodmicro.2022.109726

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