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Technological characteristics of some aborigen grape varieties specific to Nakhchivan region of Azerbaijan

Jabbar S. Najafov[1*], Leyla P. Ibrahimova[2], Ismet G. Hasanov[3], Khanim Maharromova[4], Vugar S. Salimov[5]

[1]*Nakhchivan State University, Faculty of Engineering and Architecture, Department of Reclamation and Environmental Engineering, Department of Agricultural Sciences, Azerbaijan.*
[2,3,4]*Nakhchivan State University, Republic of Azerbaijan, Nakhchivan city, University Campus, AZ7012, Azerbaijan.*
[5]*Research Institute of Viticulture and Winemaking, Prof. Dr. Azerbaijan, Baku Mehdiabad District, Azerbaijan.*

Corresponding author: Jabbar S. Najafov (*Email: cabbarnacafov@ndu.edu.az*)

Abstract

Undoubtedly, grape products grown in all regions of the world, especially table grapes, have certain unique nutritional and dietetic-therapeutic properties. As is known, in order to ensure normal nutrition and health, the food diet should not only be based on calories but also be balanced with vitamins, other biologically active substances, mineral salts, organic acids, and other components that regulate important physiological and biochemical functions within the body. In this regard, fresh grapes and industrial products made from them, which are both highly nutritious and have therapeutic properties, play a significant role in human nutrition. The grape gene pool of the Nakhchivan region is rich; yet, many grape varieties are insufficiently studied, and some rare varieties have been lost. Investigating the economic and technological characteristics of these varieties has become increasingly relevant due to the low cost of seasonal products and the high expenses associated with their storage. Cultivating and processing these rare grape varieties on a large scale can lead to long-term storage without significant additional costs, profitable sales, and reliable food security. The main objective of the conducted research is to prepare various technological products from the indigenous grape varieties of the Nakhchivan region of the Republic of Azerbaijan, compare them with the traditional regional standardized varieties, and select them for large-scale production. This study was conducted to evaluate the technological characteristics of selected indigenous grape varieties from the Nakhchivan Autonomous Republic. The grape materials used in the study were sourced from the field collection vineyard of the Plant Department of the Bioresources Research Institute (Nakhchivan), which we developed in 2004. This vineyard houses the "Rare Grape Varieties of Nakhchivan" collection, serving as the primary resource for the research. The study focused on both fresh (table) grape varieties and their potential for processing into various products. The selected grape varieties were subjected to appropriate processing methods to produce raisins, syrup, compote, jam, and table wine. Each processing technique followed standardized protocols to ensure product quality and consistency. Organoleptic evaluation was carried out to assess the sensory qualities of the processed products. The results were compared with processed products derived from standardized regional grape varieties to highlight the unique characteristics of the indigenous grapes. This methodological approach ensured the systematic evaluation of both the fresh and processed grape products, offering valuable results into their suitability for various technological applications and production processes. These comparisons have revealed that the rare grape varieties grown in Nakhchivan, in terms of both table grape quality and organoleptic evaluation of processed products, are not only on par with the standardized regional varieties but also exceed them in certain parameters. The research concluded that processed products made from many rare grape varieties specific to the Nakhchivan region received higher evaluations compared to similar products from standardized varieties. The large-scale cultivation,

propagation, preservation, and sale of these varieties both domestically and internationally would not only be profitable but also significantly contribute to the country's food security. Based on the final results of the research, it was determined that the majority (17 varieties) of the studied less common table and technical grape varieties not only match the standard Bəndi (table) and Ağ Aldərə (technical) varieties in terms of productivity and technological characteristics but also outperform them in many indicators. The introduction of these varieties into large-scale production would enrich the grape variety composition in the Nakhchivan Autonomous Republic. This, in turn, will increase the overall production of grapes, as well as the quantity and quality of valuable processed products such as table grapes, grape juice, table wine, raisins, compote, jam, and syrup. Furthermore, it will enhance production efficiency and provide opportunities for selecting and cultivating varieties that fully align with the natural conditions and specific goals of the regions where farmers and other private agricultural enterprises operate.

Keywords: Agricultural, Canned products, Cluster, food juice, Table grapes, Wine, Zante currant.

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1. Introduction

The grape gene pool of the Nakhchivan Autonomous Republic is renowned for its extraordinary diversity and richness in unique grape varieties. This region holds a significant place in viticulture history due to its exceptional contribution to the preservation and development of rare grape species. Prof. R.K. Allahverdiyev's extensive research on the grape composition in the Republic of Azerbaijan has shown that the most valuable and rare grape varieties cultivated by local growers and breeders are predominantly concentrated in Nakhchivan. This conclusion is supported by various scientific studies and is frequently highlighted by numerous scholars and experts [1-4].

However, despite this richness, the economic and technological potential of many indigenous grape varieties from Nakhchivan remains underexplored. While considerable research has focused on identifying and preserving these varieties, their full potential, especially for large-scale production and processing, has not been sufficiently studied. The gap in research regarding their comparative advantages over regional standardized varieties and the lack of exploration into their processing applications limit their widespread use. This study aims to bridge this gap by evaluating the technological and production characteristics of indigenous Nakhchivan grape varieties, comparing them with standardized regional varieties, and assessing their suitability for large-scale production.

The contribution of this study is to provide insights into the potential of these local varieties for producing high-quality processed products such as raisins, syrup, and table wine, which can contribute significantly to the region's agricultural economy and food security. The research specifically seeks to answer the following questions:

- How do the indigenous grape varieties of Nakhchivan compare with traditional regional varieties in terms of technological and economic potential?
- What are the advantages of these local varieties for large-scale production and processing?
- How can these varieties contribute to the diversification of agricultural products and food security in the Nakhchivan region?

The paper is structured as follows: the next section reviews the existing literature on grape cultivation and the technological potential of indigenous varieties. The methodology section outlines the approach taken to assess the selected grape varieties. The results and discussion section presents the findings and their implications, followed by conclusions and recommendations for future research and practical applications.

2. Literature Review

Grapes, especially table grapes, cultivated worldwide, are recognized for their exceptional nutritional and therapeutic benefits. Proper human nutrition and health necessitate a balance in physiological and biochemical functions, which extends beyond mere caloric intake. It also requires incorporating essential vitamins, biologically active compounds, mineral salts, organic acids, and other crucial elements found in food products [5]. Consequently, both fresh grapes and industrial products derived from them play a vital role in human diets, offering not only nutritional value but also therapeutic advantages.

Grapes, whether consumed fresh or processed, are high-energy foods. Fresh grapes typically provide 0.7-1.2 kcal/g, while dried raisins offer 3.0-3.2 kcal/g. These fruits are renowned for their taste and their rich content of sugars (glucose,

fructose), organic acids (such as malic, tartaric, and citric acids), and vital minerals, including potassium, calcium, and iron. Grapes also contain various vitamins (such as vitamin C and B-group vitamins), provitamin A (carotene), bioflavonoids, enzymes, and phytoncides, making them a valuable food and therapeutic resource [6]. In both fresh and processed forms, grapes have demonstrated significant health benefits, including antioxidant properties, heart health benefits, and potential cancer-preventive effects [7].

Fully ripe grape berries contain 65-85% water, up to 30% sugars, and 0.5-1.4% organic acids. They also provide trace amounts of vitamins, including B1 (thiamine) and vitamin C, with significant variations in their content depending on the type of grape. Notably, one kilogram of grapes yields about 900 kilocalories, a value lower than apples or pears, which provide more energy per kilogram [8].

In addition to their nutritional content, grapes, and their essential oils and hormones have been shown to stimulate appetite, aid digestion, and reduce fatigue, contributing to the body's resistance against disease. This has led the Scientific Research Institute of Nutrition to recommend an annual consumption of 76 kilograms of fruits, including grapes, for optimal health [9].

Throughout history, grapes have been lauded for their therapeutic properties. Ancient scholars such as Hippocrates and Avicenna, as well as modern figures like Muhammad Yusif Shirvani, have recognized their health benefits, further emphasizing their longstanding cultural and medical significance [10].

Nakhchivan Autonomous Republic is distinguished by unique natural conditions ideal for viticulture, including fertile soils, abundant sunlight, and pure irrigation water. These factors contribute to the exceptional quality of Nakhchivan's grapes, which are known for their vibrant colors, rich compositions, and therapeutic properties. As Sharifov [11] notes in "*Azerbaijan Grapes"*, the golden and amber grapes from Nakhchivan are revered for their healing qualities, capable of alleviating ailments and providing strength and vitality to the body [11].

The importance of quality standards for table grapes is recognized globally. In many countries, including Turkey, there are clear guidelines regarding the desired characteristics of grape clusters and berries. For instance, Turkey produces a range of grape varieties, with about 30% designated for table consumption and significant percentages allocated to drying, raisin production, and winemaking. This diversity in grape use highlights the increasing global development of grape cultivation for various purposes [12].

In recent studies (2017-2022), we have focused not only on selecting promising grape varieties but also on producing ecological products by utilizing plant-derived substances instead of chemicals. Various methods for utilizing plant raw materials to prepare technological products have been explored, and their therapeutic properties have been analyzed. However, it is important to note that, as of now, this ecological approach is limited to small private farms [1, 13, 14].

For table grapes, it is crucial to ensure that the grapes can be transported and delivered to their destination in optimal condition, particularly during loading, transportation, and unloading processes [15]. Furthermore, the sugar-acidity ratio in table grapes should be balanced to maintain their quality. Premium-quality table grapes should exhibit high color intensity, sweetness, flavor, and uniform consistency. The clusters should present aesthetically pleasing shapes, and the berries should be evenly distributed and covered with a waxy layer, indicating high-quality cultivation practices [16].

3. Methodology

The material for the conducted research consisted of selected grapevines from 20 varieties grown in the Nakhchivan Autonomous Republic (10 table grapes and 10 technical varieties).

The research was carried out at the experimental field of the Bioresources Institute of the Azerbaijan National Academy of Sciences, Nakhchivan Branch, where these rare grape varieties were planted in 2004. The technological characteristics of the products obtained from these varieties were studied, and the necessary analyses were conducted in the institute's fruit, vegetable, viticulture, and biochemistry laboratories.

Technological products were prepared at the Babak Wine 2 "Yeddilar ASK" wine processing plant, and their quality indicators were determined through organoleptic evaluation. For each studied grape variety, from the start of ripening, the sugar percentage in the juice was measured every 5 days until full ripening. The sugar content was calculated based on the specific gravity of the juice at 20°C, and the acidity was determined by titration with a 1/3 normal NaOH solution. The acidity of the Zante currant was also determined by titration, while the sugar content was measured using Bertrand's method for determining sugars in dry substances [7]. Currently, grapes are dried using the Shtabel method, which experts consider the most effective. Furthermore, this method has been adopted based on the recommendations of Guliyev and Najafov [2] for the conditions in the Nakhchivan Autonomous Republic [17, 18].

The investigation of table grapes and their processed products was conducted using the method outlined by Morozova [19] involving both laboratory analyses and sensory evaluations to assess their quality and organoleptic characteristics. Based on the characteristics of the studied grape varieties, products such as grape juice, compote, jam, table wine, and molasses were prepared from the corresponding varieties. These products were then organoleptically evaluated using the 100-point system through tasting, following the methodology described by Morozova [19].

4. Results and Discussion

As a result of the research, appropriate products have been developed for the utilization of the studied grape varieties, which were then analyzed comparatively.

Table grapes. Although all grape varieties grown in practice can be consumed fresh, table grapes are specifically characterized by infrequent seeds, appealing shapes and colors of berries, relatively firm skins, juicy yet not overly watery

flesh, and harmonious sugar-acid proportions. These traits collectively result in excellent taste, delicate texture, and pleasant aroma, making table grapes highly valued [2, 20].

The Nakhchivan Autonomous Republic enjoys uniquely favorable natural conditions, such as fertile soils rich in essential macro and micro elements for plant nutrition, clear and sunny skies during the vegetation period, high solar radiation throughout the region, and crystal-clear irrigation waters. These factors collectively enhance the growth of high-quality grapes, distinguished by their beautiful clusters and berry shapes, vibrant colors, rich composition, pleasant aroma, delicious taste, high nutritional value, and medicinal properties.

Recent studies emphasize the influence of environmental factors on grape quality. For instance, research by Marta, et al. [21] highlights the importance of balanced irrigation practices in optimizing grape sugar-acid content [21] while contradictory findings by Sarrazin, E., et al. suggest that overly sunny conditions may sometimes compromise aroma compound development [22]. These perspectives provide new insights into the delicate interplay between natural conditions and grape quality.

Standards for table grapes in many countries require that clusters and berries meet specified quality criteria for each variety. Products must remain free from decay and damage, ensuring that no foreign odors or tastes affect the grapes' marketability. Table grapes should also be adequately ripened to endure the logistical processes of loading, transportation, and unloading, arriving at their destination in perfect condition. Additionally, harmonious sugar-acid ratios are crucial. Premium-quality table grapes must display excellent color, aroma, taste, and flavor, with clusters and berries of attractive appearance. The berries should achieve the consistency and ripeness expected for their variety, be evenly distributed on the cluster, have firm skins, and be covered with a protective waxy layer [23].

The organoleptic evaluation of 10 rare table grape varieties included in this study was conducted in comparison with the local Bandi variety, previously ranked among the top 150 grape varieties in the former USSR. The tasting took place when all the studied varieties were fully ripe. As shown in Table 1, Duzali, et al. [24] were found to match the Bandi variety in terms of table quality, while Duzali, et al. [24] exceeded it.

Recent evaluations by Li, et al. [25] underscore the importance of genetic diversity in improving organoleptic traits [25]. Additionally, contrasting views from Valiyeva [26] argue that certain local varieties often outperform commercialized breeds due to their unique adaptations to regional conditions [26]. These findings reinforce the potential of rare varieties, such as those studied here, to surpass established standards.

Table 1.
Tasting scores of the studied table grape varieties (10-point system)

Row No.	Grape varieties	Grading			
		Appearance of Bunch and Berry (0.1 – 2.0)	Taste and Aroma of Berry (1.0 – 5.0)	Consistency of Berry Flesh and Skin (0.9 – 3.0)	Total Score
1	Bandi (st. sort)	1.6	4.1	2.5	8.2
2	Duzali	1.5	4.0	2.5	8.0
3	Khanimi	1.6	4.2	2.6	8.4
4	Khazani	1.5	4.1	2.5	8.1
5	Gara Khalili	1.6	3.8	2.3	7.7
6	Gara Kurdashi	1.7	4.6	2.8	9.1
7	Gizil uzum (Nakh)	1.8	4.6	2.8	9.2
8	Nakhshabi	1.7	4.5	2.7	8.9
9	Sahibi	1.9	4.5	2.7	9.1
10	Sari Aldara	1.5	4.1	2.5	8.1
11	Shahangiri	2.0	4.6	2.6	9.2

Dried Products (Zante Currants). Zante currants, like raisins, are highly caloric food products that allow for the year-round use of grapes under normal conditions. Many researchers argue that the Nakhchivan Autonomous Republic offers the most favorable natural conditions for the production of raisins and Zante currants, free of additional costs by harnessing solar energy under open skies, ensuring high quality. These conditions are unparalleled not only within Azerbaijan but across all CIS countries [27].

In contrast, industrial methods are predominantly employed in regions such as Jalilabad in Azerbaijan and many countries lacking favorable drying conditions. These methods rely on artificial heating in specialized facilities. However, several studies indicate that such methods negatively affect the natural color and consistency of the grapes, leading to a notable decline in quality [28]. In 2016 studies, such as those by Goula, et al. [29] corroborated this claim by demonstrating significant nutrient degradation in artificially dried grapes [29]. However, other researchers, including [30] contend that advancements in controlled drying techniques have mitigated these issues, maintaining color and nutritional integrity even in less favorable climates [30].

Traditionally in Nakhchivan, drying is predominantly carried out with grape varieties such as Hanagyrna, and to a lesser extent, Agh and Bandi [31]. To broaden the range of drying-suitable varieties, Zante currant samples were prepared from table and technical grape varieties, including Duzali, et al. [24]. The chemical composition and organoleptic properties of these samples were then evaluated and compared with dried products made from standard varieties like [31, 32].

The Shtabel method is currently the most widely employed drying technique, recognized by experts for its effectiveness. Additionally, modifications tailored to the climatic conditions of the Nakhchivan Autonomous Republic, as recommended by Guliyev and Najafov [17] and Najafov [18] have been implemented. While traditional methods generally result in higher-quality products, recent research by Srivastava, et al. [33] highlights the potential of integrating solar-assisted hybrid drying systems to further optimize quality and energy efficiency Srivastava, et al. [33].

Our investigation revealed that indigenous table and technical grape varieties Duzali, et al. [24]-not only matched but often surpassed the standard Agh and Bandi [31] varieties in terms of yield, chemical composition, and organoleptic qualities of dried products. These findings align with those of Kaushal, et al. [34] who emphasized the significance of cultivar selection in optimizing drying outcomes [34]. By increasing the cultivation of these superior varieties, the volume of high-quality dried grape production in Nakhchivan Autonomous Republic could be significantly enhanced.

Table 2.
The quality indicators of Zante currant products made from less common grape varieties (on a 10-point scale).

Row No.	Grape varieties	Before drying		Dry Product Yield, %	In dry product (Zante currant)			Color of dry product	Tasting Score (10-point scale)
		Sugar, %	Acidity, g/l		Moisture, %	Sugar, %	Acidity, g/l		
1	Ağ Aldara (st.sort)	18.1	4.1	23.09	17.04	65.26	1.89	Light brown	7.9
2	Bandi (st. sort)	21.3	4.1	24.70	16.47	67.52	1.72	Light yellow	7.8
3	Duzali	21.3	3.7	24.81	16.71	69.43	1.67	Light yellow	8.6
4	Khanimi	19.2	3.2	23.64	17.04	67.12	1.63	Light yellow	8.4
5	Nakshabi	22.6	3.7	26.38	16.72	71.47	1.59	Golden yellow	8.7
6	Sari Aldara	18.4	4.2	23.17	16.28	64.57	1.82	Light yellow	8.3
7	Shahangiri	22.4	3.9	26.12	16.63	72.16	1.74	Light yellow	8.7
8	Talibi	18.9	4.2	23.43	17.26	65.62	1.76	Light yellow	8.1

Grape syrup. Grape syrup is considered a valuable food product due to its richness in various nutrients and minerals, making it an important regulator of normal nutrition.

Grape syrup is a high-calorie food product made from the peel, flesh, and cleaned seeds of grapes. Due to the absence of fats and proteins in its chemical composition, grape syrup is considered similar to mother's milk. Therefore, it is sometimes used in the nutrition of breastfed infants. In terms of nutrition, 1 liter of grape syrup is equivalent to 1.7 liters of cow's milk, 650 grams of beef, 1 kilogram of fish meat, 300 grams of cheese, 500 grams of bread, 3-5 eggs, 3.5 kilograms of tomatoes, and 1.5 kilograms of apples, pears, or peaches [35].

Natural grape syrup prepared according to proper technologies can be preserved without any changes in composition for up to 1 to 4 years and can be used in its full quality during this period [4, 36].

According to the research, the quality of natural grape syrup depends not only on the preparation technology but also on the biological characteristics of the grape varieties used, the natural conditions of the region where they are grown, and the effectiveness of the applied agricultural techniques. Therefore, the chemical composition of the syrup is directly related to its quality.

As part of the research program conducted by us, samples of grape syrup were prepared from grape varieties that were studied for their harmonious taste, aroma, attractive appearance, and beautiful color. These samples are stored for one year and then evaluated using a 10-point sensory evaluation system.

The color of the syrups prepared from the Jalali and Khazani varieties is crimson-red, while the Sahibi variety exhibits a light-crimson color, and the remaining varieties have a golden-yellow hue. All syrup samples presented to the tasting committee received scores of 8 or higher, with the Jalali, Sahibi, and Shahtakhti varieties even being rated between 9.1 and 9.3 points (Table 3). Therefore, it can be concluded that these varieties are suitable for the widespread production of grape syrup.

Table 3.
Organoleptic evaluation of syrup samples prepared from less common grape varieties (10-point scale).

Row№	Grape varieties	Evaluation Elements of the Syrup								
		Color of syrup	Sugar content,%	Acidity, q/dm^3	Clarity (1-5)	Color (1.0-5.0)	Bouquet (1.0-3.0)	Taste (1.0-5.0)	Typicity of syrup type (1.0-10.0)	Total score
1	Jalali	Crimson red	22.4	3.7	5	5	2.8	4.7	8	9.3
2	Khanimi	Golden yellow	19.2	3.5	4	5	2.6	4.6	8	8.9
3	Khazani	Crimson red	21.8	3.7	4	4	2.8	4.5	7	8.8
4	Nakhshabi	Golden yellow	22.6	3.7	4	4	2.7	4.5	7	8.7
5	Sahibi	Light crimson	19.8	3.7	5	5	2.8	4.7	8	9.3
6	Shahangiri	Golden yellow	22.4	3.9	3	4	2.6	4.5	7	8.4
7	Shahtakhti	Golden yellow	21.5	3.8	5	5	2.7	4.6	8	9.1
8	Talibi	Golden yellow	18.9	4.2	4	4	2.8	4.5	7	8.8

Table wine is an alcoholic beverage, available in white, pink, or red colors, obtained from the natural fermentation of grapes, fruits, and berry fruits. Depending on the sugar content of the grapes or berry fruits used in its preparation, table wine contains 9-14% ethyl alcohol and 0.3% sugar. In addition to this, it contains a range of beneficial components for the human body, such as various fruit acids (apples, quinces, etc.), a variety of vitamins, minerals, pectin, and more [10, 37].

The quality and taste of grape wine depend not only on the variety from which it is made but also on the climate, soil conditions where the grapes are grown, the harvest time, and, of course, the winemaking technology [38].

According to recent data, grape wine is currently produced in 45 countries around the world, but it is consumed in almost every country [10]. Even the ancient Romans believed that all well-provisioned households should have wine, in addition to grain, vegetables, and olive oil [39].

Samples of table wine were prepared from 10 technical grape varieties included in the conducted study. In addition to the Agh Aldara variety used to produce the famous "Araz" brand table wine, these samples were prepared at the No. 2 Tumbul winery in the Babek district. After being aged and stored for one year, the wines were comparatively tasted and evaluated organoleptically (Table 4).

Table 4.
Organoleptic evaluation of table wine samples prepared from studied technical grape varieties (10-point scale).

Row No.	Grape varieties	Evaluation Elements							
		Alcohol content, C^0	Colour of wine	Clarity (0.1-0.5)	Color (0.1-0.5)	Bouquet (1.0-3.0)	Taste (1.0-5.0)	Typicity of wine type (0.1-1.0)	Total Score
1	Agh Aldara (st.sort)	9.03	Golden yellow	0.4	0.5	2.5	4.5	1.0	8.9
2	Agh Kalampur	9.31	Light yellow	0.4	0.4	2.5	4.0	0.7	8.0
3	Jalali	11.42	Red	0.4	0.5	2.5	4.5	1.0	8.9
4	Dash Gara	10.75	Red	0.3	0.4	2.0	4.0	0.7	7.4
5	Khatini (Nakh.)	10.37	Red	0.3	0.4	2.4	4.0	0.7	7.8
6	Khatmi	10.32	Golden yellow	0.4	0.4	2.0	3.5	0.6	6.9
7	Shahtakhti	9.07	Golden yellow	0.4	0.5	2.5	4.5	1.0	8.9
8	Talibi	10.51	Light yellow	0.4	0.4	2.3	4.5	0.8	8.4
9	Tula gozu	10.27	Red	0.4	0.4	2.3	4.0	0.8	7.9
10	Tulku guyrughu	11.04	Red	0.3	0.4	2.3	4.0	0.7	7.7
11	Zalkha	10.61	Light yellow	0.4	0.4	2.3	4.0	0.7	7.9

When the prepared wine samples were organoleptically evaluated, as indicated in Table 4, it became apparent that in terms of quality indicators from the selected technical grape varieties, Jalali and Shahtakhti, the famous "Araz" brand table wine made from the standard Agh Aldara variety has the same rating, while Talibi is close to it. Overall, except for Khatmi, all other varieties have been rated between 7.4 and 8.0, which can be considered sufficiently high for table wines.

5. Canned Products. Canned products are prepared using white, partly pink, and red grapes with high sugar content and low acidity. Based on this, samples of compote were prepared from red Gizil uzum, white Nakhshabi, and Sari Aldara, as well as pink Sahibi grape varieties. Jam was made from white Khanimi, Shahangiri, and Talibi grape varieties. Additionally, molasses was prepared from Agh Kalampur, Khatini, and Shahtakhti grape varieties. These samples were then organoleptically evaluated (Table 5).

Table 5.
Organoleptic evaluation of canned products (on a 10-point scale)

Row No.	Grape varieties	Product type	Evaluation Elements					
			Clarity (0.1-0.5)	Color (0.1-0.5)	Bouquet (1.0-3.0)	Taste (1.0-5.0)	Product typicity (0.1-1.0)	Total Score
1	Gizil uzum (Nax)	Compote	0.4	0.4	2.7	4.5	0.7	8.7
2	Nakshabi	Compote	0.4	0.4	2.6	4.4	0.7	8.5
3	Sahibi	Compote	0.4	0.5	2.7	5.0	1.0	9.6
4	Sari Aldara	Compote	0.4	0.4	2.6	4.5	0.8	8.7
5	Khatmi	Jam	0.4	0.4	2.3	3.9	0.7	7.7
6	Shahangiri	Jam	0.4	0.4	2.5	4.0	0.8	8.1
7	Talibi	Jam	0.4	0.4	2.5	4.0	0.8	8.1
8	Agh Kalampur	Molasses	0.4	0.4	2.4	4.0	0.7	7.9
9	Khatini (Nakh)	Molasses	0.4	0.4	2.3	3.9	0.7	7.7
10	Shahtakhti	Molasses	0.4	0.4	2.6	4.1	0.8	8.3

As seen from Table 5, canned products have been rated sufficiently high for their organoleptic qualities. This gives us a reason to believe that sparsely distributed grape varieties selected for the production of canned products can be considered highly beneficial.

5. Conclusion

This research has provided valuable insights into the utilization of different grape varieties for various product preparations, particularly focusing on their organoleptic and chemical characteristics. The findings highlight the suitability of several indigenous grape varieties for producing high-quality products such as table wine, grape syrup, dried products, and canned goods, offering a significant contribution to the agricultural and food processing industries in regions with similar soil and climate conditions as the Nakhchivan Autonomous Republic.

5.1. Implications

- Among the table grape varieties studied, Duzali (8.0), Khazani (8.1), Gara Khalili (7.7), and Sari Aldara (8.1) were comparable to the standard Bandi variety (8.2). However, Khanimi (8.4), Gara Kurdashi (9.1), Gizil üzüm (9.2), Nakhshabi (8.9), and Shahangiri (9.2) varieties surpassed it. We concluded that almost all of these varieties can be cultivated in large-scale vineyards, providing fresh table grapes for the population and generating financial income.
- Based on the evaluation of dried grape products, Duzali (8.6), Khanimi (8.4), Nakhshabi (8.7), and Shahangiri (8.7) varieties significantly outperformed the standard Agh Aldara (7.9) and Bandi (7.8) varieties in terms of dry product yield, chemical composition, and organoleptic qualities. According to the conducted scientific research, increasing the cultivation of these grape varieties will allow for a higher volume of dried grape product production in the Nakhchivan Autonomous Republic, contributing to long-term agricultural and food security.
- Juice samples from all varieties scored above 8 points, with Jalali, Sahibi, and Shahtakhti receiving scores of 9.1 to 9.3 for their organoleptic qualities. As a result, these varieties can be cultivated in large-scale vineyards for the production of ecologically clean juice.
- According to the organoleptic evaluation of prepared wine samples, the less common technical grape varieties Jalali and Shahtakhti scored the same 8.9 points as the famous Agh Aldara variety, with Talibi being close to this level. Overall, except for Khatmi, all other varieties were rated between 7.4 and 8.0, which is considered quite high for table wines. For individuals who do not consume alcoholic beverages in their daily lives, it is recommended to convert the obtained wine into vinegar as an alternative (grape juice first turns into wine, then into vinegar at high temperatures, which is very important for health. Additionally, vinegar helps beneficial bacteria in the human body fight harmful organisms).
- Canned products were rated highly for their organoleptic qualities. Therefore, the rare grape varieties selected for canned products can be cultivated extensively across the country to produce high-quality, healthy, and nutritious processed products.
- Based on the results of our scientific work, it is possible to ensure food security and achieve significant financial gains through the production of healthy products. These grape varieties are recommended for cultivation on large-scale farms and other production enterprises.

5.2. Limitations

Although the study provides valuable insights, there are a few limitations to be considered. The samples were limited to a specific geographical region, which may pose challenges in generalizing the findings to other areas with different climatic and soil conditions. However, any region with similar geographical characteristics to the studied area can cultivate these indigenous grape varieties. Additionally, the study focused mainly on sensory and chemical evaluations, and further research is required to explore the long-term storage stability and potential nutritional impacts of these grape products.

5.3. Future Research

Future studies could investigate the impact of climate change on grape quality and product consistency, particularly in regions with variable environmental conditions. Further research into the optimization of processing technologies, including drying methods and fermentation processes, could help improve the yield and quality of grape-based products. Additionally, exploring the health benefits of the mentioned grape varieties, particularly in relation to their antioxidant properties, could drive ecological clean product production and the development of new marketing strategies.

5.4. Recommendations

Based on the results of this study, the following recommendations are made:

- The cultivation of identified grape varieties such as Khanimi, Shahangiri, and Nakhshabi should be encouraged, as this will contribute to local food production and economic growth.
- Further research should be supported on the stable long-term cultivation of grape products, and the potential nutritional benefits these products can offer to consumers should be explored.
- Attention should be given to alternative processing methods, such as vinegar production, to maximize the health benefits of wine-derived products.
- The production of dried grape products from high-quality grape varieties should be promoted. Modern and traditional drying methods should be used to preserve their nutritional value and ensure long-term storage. Additional research on the health benefits of dried grapes is recommended, which could increase their market potential.

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