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Comparative Study of the Mechanical Composition and Physicochemical Parameters of the "Areni Sev" Grape Variety and its Clones

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ABSTRACT

Within the scope of this study, a comparative analysis was conducted on the mechanical composition and physicochemical properties of the Vitis vinifera cultivar "Areni Sev" and its three distinct clones - "Nosr Areni", "Areni Sev Clone №9", and "Areni Sev Clone №15". The objective of the research was to assess the technological suitability and production efficiency of these clones for winemaking applications. The results demonstrated that the "Nosr Areni" clone, with the highest juice content (82.78%) and rachis composition index (4.8), is the most efficient in terms of sugar yield, contributing to higher wine production efficiency and a reduction in product cost. "Areni Sev Clone №. 9", in turn, is characterized by well-developed pulp, firm berry mass, and a high structural index, ensuring strong technological and breeding potential. Overall, the clonal variants, particularly "Nosr Areni" and "Clone №9", exhibited superior production and technological characteristics, enhancing the applied value of this grape cultivar in the winemaking industry.

Introduction

Since ancient times, viticulture practices have recognized cases of distinct traits and heritable variability in perennial crops (Zarmaev, 2013). Due to the variability of perennial plant cultivars, their vegetatively propagated progeny are commonly regarded as groups of clones, unified by a set of economically valuable and biological characteristics, while differing in various morphological or physiological traits such as color, shape, size, ripening period, and phenophase (Zarmaev, 2014).

The purpose of clone selection may include increasing the yield of specific cultivars, improving fruit quality, identifying early-ripening clones, and other objectives (Zhukovsky, et al., 1972). Thanks to clonal selection, vineyard productivity has generally increased 2–5 times across countries and regions, including Germany, Italy, France, and California (Zarmaev, 2015).

Only in the last decade has research on the effectiveness of clonal selection received significant attention, as it contributes to cultivar improvement and productivity

enhancement (Zarmaev, 2017). Determining the suitability and intended use of a cultivar relies heavily on oenological research. Oenology primarily involves studying the structural components of the rachis and fruit according to their mechanical composition. During clonal selection, attention is focused on improving cultivar traits such as rachis and berry dimensions, the weight of 100 berries, and the number of berries per cluster.

It should be noted that in winemaking, the ratio of the rachis, berries, berry skin, pulp, seeds, juice, and pedicel is determined through mechanical analysis. Notably, this ratio can vary depending on the grape cultivar, soil and climatic conditions of cultivation, berry ripeness, and applied agrotechnical practices (Troshin, et al., 2018).

Analysis of the mechanical composition of grapes allows the determination of the characteristic structure of the cluster for a given cultivar, as well as the proportional relationships among its various components, which is crucial from a technological standpoint (Grigoryan, et al., 2024).

The aim of this study is to conduct a comparative investigation of the mechanical composition and physicochemical parameters of the "Areni Sev" cultivar and its clones. This approach enables the identification of their production potential and the selection of clones that ensure optimal yield and quality for implementation in winemaking production.

Materials and methods

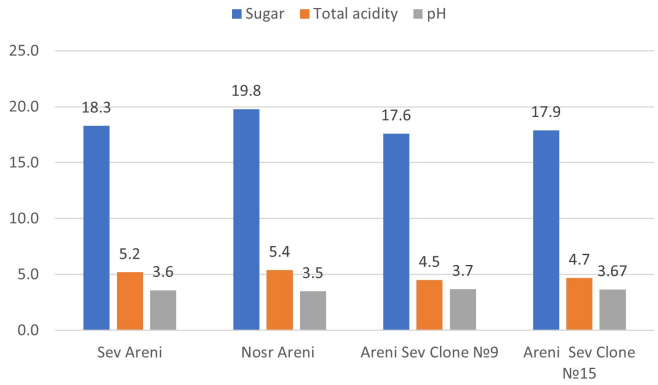
A comparative study was conducted on the mechanical composition and physicochemical parameters of the "Areni Sev" grape cultivar and its clones: "Nosr Areni", "Areni Sev clone №9", and "Areni Sev clone №15". For each clone and the cultivar, five clusters were analyzed in three replicates. The study was carried out in 2023–2024 at the National Grape Collection Vineyard located in the Ejmiatsin province of Armavir region, Armenia.

Areni is classified among late-ripening wine grape cultivars (Ayvazyan, et al., 2015). The mechanical composition of the cultivars was assessed according to the methodology developed by N.N. Prostoserdov (1935). Specifically, the weight of the cluster, berry skin, and pedicel, as well as the number of berries per cluster and the weight of seeds, were determined. The berry skin was weighed immediately after separation from the berries. Based on the obtained data, the structure and composition of the clusters of the studied cultivar and clones were compared.

The sugar content of the grape juice was determined using a refractometric method with a laboratory refractometer, and the results were expressed in °Brix. Titratable acidity was measured by titration with a 0.1 N sodium hydroxide (NaOH) solution using phenolphthalein as an indicator, and the results were expressed as grams per liter of tartaric acid equivalent (g/L). The pH of the grape juice was measured using an electronic pH meter in accordance with ISO 10523 standard (International Organisation of Vine and Wine, 2022).

Results and discussions

The improvement of the agrobiological characteristics of locally cultivated grape varieties through clonal selection plays a crucial role in the production of high-quality wines. Key primary indicators characterizing the grapes include sugar content, titratable acidity, and pH. These parameters significantly influence the future wine's aroma, flavor, and overall quality. The physicochemical parameters of the studied "Areni Sev" variety and its clones are presented in Figure 1.



Picture 1. Physicochemical characteristics of the Sev Areni Sev variety and its clones (composed by the authors).

Table 1. Mechanical composition of the "Areni Sev" and its clones*

Grape variety and clones	Bunch length, cm	Bunch width, cm	Bunch mass G	Number of berries in the bunch, n	Berries mass, g	Stem mass, g	Skin mass, g	Seed mass, g	Hard residue mass, g	Berries pulp+juice, g
Areni Sev	18	10,4	316,7	161	304,7	12	53,9	13,9	79,8	236,9
Nosr Areni	11,6	7,5	118,1	50	113,3	4,8	10,8	4,7	20,3	97,8
Areni Sev Clone №9	19,8	13,9	502,3	194	485,8	16,5	51,4	23,3	91,2	411,1
Areni Sev Clone №15	18,1	11,7	406,7	144	392,9	13,8	43,2	20,1	77,1	329,6

Table 2. Bunch structure of the "Areni Sev" grape variety and its clones*

Grape variety and clones	Average bunch mass, g	Number of berries in the bunch, n	Berries mass, g	Berries ratio to the bunch, %	Stem mass, g	Stem ratio to the bunch, %	Bunch structure index	Berries index
Areni Sev	316,7	161	304,7	96,2	12	3,78	25,4	50,8
Nosr Areni	118,1	50	113,3	95,9	4,8	4,06	23,6	42,3
Areni Sev Clone №9	502,3	194	485,8	96,7	16,5	3,28	29,4	38,6
Areni Sev clone №15	406,7	144	392,9	96,6	13,8	3,39	28,4	35,4

*Composed by the authors.

It was observed that the highest sugar content was recorded in the "Nosr Areni" clone, while the lowest was found in "Areni Sev Clone №9". Titratable acidity and pH did not differ significantly among the studied clones and the main variety; however, "Areni Sev Clone №9" exhibited the lowest acidity and the highest pH, making it particularly suitable for producing light red and rosé wines.

The results of the mechanical composition analysis of the "Areni Sev" variety and its clones ("Nosr Areni", "Areni Sev Clone №9", and "Areni Sev Clone №15") are presented in Table 1. The lengths of the grape clusters were 18.0 cm, 11.6 cm, 19.8 cm, and 18.1 cm, respectively, while the widths measured 10.4 cm, 7.5 cm, 13.9 cm, and 11.7 cm, respectively. The cluster weights were 316.7 g, 118.1 g, 502.3 g, and 406.7 g, respectively, with the corresponding fruit weights being 304.7 g, 113.3 g, 485.8 g, and 392.9 g. The highest stem weight was recorded in "Areni Sev Clone №9" (16.5 g), followed by "Areni Sev Clone №15" (13.8 g), the main "Areni Sev" variety (12.0 g), and "Nosr Areni" (4.8 g). The greatest seed weight was observed in "Areni Sev Clone №9" (23.3 g), "Areni Sev Clone №15" (20.1 g), the main "Areni Sev" variety (13.9 g), and "Nosr Areni" (4.7 g).

The structure of a grape cluster is characterized by its average weight, the number of berries, the weight of the berries and stem, their percentage composition within the cluster, as well as by the cluster structural index. A higher structural index indicates more efficient utilization of the cluster and results in increased juice yield.

The cluster structural index is determined as the ratio of the combined berry weight to the stem weight (Table 2).

The grape variety "Areni Sev" and its clones — "Nosr Areni", "Areni Sev Clone №9", and "Areni Sev Clone №15" — differ significantly in terms of cluster and berry weight. Compared to the "Areni Sev" variety, "Areni Sev Clone №9" produces a higher number of berries. Specifically, the "Areni Sev" variety had 161 berries per cluster, "Nosr Areni" had 50 berries, "Areni Sev Clone №15" had 144 berries, and the highest berry count was recorded in "Areni Sev Clone №9", with 194 berries per cluster.

The maximum stem weight was observed in "Areni Sev Clone №9" (16.5 g), followed by "Areni Sev Clone №15" (13.8 g), the "Areni Sev" variety (12 g), and "Nosr Areni" (4.8 g). No significant differences were observed in the ratio of berry to stem weight among the "Areni Sev" variety and its clones. The cluster structural index, calculated as the ratio of berry weight to stem weight, was 25.4 for the "Areni Sev" variety, 29.4 - for "Areni Sev

Clone №9", 23.6 - for "Nosr Areni", and 28.4 - for "Areni Sev Clone №15".

According to the study, the berry index of the "Areni Sev" grape and its clones, defined as the number of berries per 100 g of cluster, was as follows: 50.8 for "Areni Sev", 38.6 for "Areni Sev Clone №9", 42.3 for "Nosr Areni", and 35.4 for "Areni Sev Clone №15".

The results of the berry composition analysis — including the weight of 100 berries and 100 seeds, the number and weight of seeds per 100 berries, and the weights of berry skin and pulp plus juice — are presented in Table 3. Of particular importance is the berry composition index, calculated as the ratio of pulp plus juice weight to berry skin weight.

In the "Areni Sev" grape variety, the number of seeds per 100 berries was 168, while in the clones it was 104 in "Nosr Areni", 182 in "Areni Sev Clone №9", and 215 in "Areni Sev Clone №15". The weight of seeds per 100 berries was highest in "Areni Sev Clone №15" (29.9 g), followed by "Areni Sev Clone №9" (21.8 g), the "Areni Sev" variety (14.5 g), and "Nosr Areni" (9.8 g).

Notably, the maximum weights for both 100 berries and 100 seeds were recorded in "Areni Sev Clone №15", with 276 g and 29.9 g, respectively; in "Areni Sev Clone №9", 262.5 g and 21.8 g; in the "Areni Sev" variety, 247.6 g and 14.5 g; and in "Nosr Areni", 241.2 g and 9.8 g.

For technical grape varieties, the berry composition index is also of significant importance. The highest value was observed in "Nosr Areni" (9.75), followed by "Areni Sev Clone №9" (8.1), "Areni Sev Clone №15" (7.2), and the lowest in the "Areni Sev" variety (5.96).

During grape processing, particular attention is also paid to the ratio of berries to the rachis.

The structure of the grape cluster is characterized by the composition of its constituent parts—rachis, skin, seeds, stem, pulp, juice—and their percentage ratios, which vary depending on the grape variety, ripeness stage, ecological factors, and climatic conditions.

The parameters of the individual components of the "Areni Sev" grape variety and its clones are presented in Table 4.

According to the research results, in the clusters of the "Areni Sev" grape variety, the stem content was 3.8% and the skin content 17%. In the "Nosr Areni" clone, these values were 4.1% and 9.14%, in "Areni Sev Clone №9"—3.3% and 10.23%, and in "Areni Sev Clone №15"—3.4% and 10.6%, respectively. Table 4 shows that the highest skin content was observed in the "Areni Sev" variety, while the stem content was highest in the "Nosr Areni" clone.

Table 3. Berry composition of the "Areni Sev" grape variety and its clones*

Grape variety and clones	Mass, g		Number of seeds in 100 berries, n	Weight of 100 berries, G			Berry composition index
	100 berries	100 seeds		Seed	Skin	Pulp+juice	
Areni Sev	247,6	8,65	168	14,5	33,5	199,6	5,96
Nosr Areni	241,2	9,4	104	9,8	21,52	209,9	9,75
Areni Sev Clone №9	262,5	12	182	21,8	26,5	214,2	8,1
Areni Sev Clone №15	276	13,9	215	29,9	30	216,1	7,2

Table 4. Bunch composition indicators*

Grape variety and clones	Composition of individual parts in the bunch, %					Bunch composition index
	Stem	Skin	Seed	Hard residue	Pulp+juice	
Areni Sev	3,8	17	4,39	25,19	74,81	2,97
Nosr Areni	4,1	9,14	3,98	17,22	82,78	4,8
Areni Sev clone №9	3,3	10,23	4,64	18,17	81,83	4,5
Areni Sev clone №15	3,4	10,6	4,94	18,94	81,06	4,3

*Composed by the authors.

The seed content was highest in “Areni Sev Clone №15” (4.94%), followed by the “Areni Sev” variety (4.39%), “Nosr Areni” (3.98%), and “Areni Sev Clone №9” (4.64%).

For technical grape varieties, the percentage of pulp plus juice is a particularly important indicator. This value was highest in the “Nosr Areni” clone (82.78%), followed by “Areni Sev Clone №9” (81.83%), “Areni Sev Clone №15” (81.06%), and the “Areni Sev” variety (74.81%). All clones exceeded the parent variety in this respect. The mass of the cluster skeleton was highest in the “Areni Sev” variety (25.19%), followed by “Areni Sev Clone №15” (18.94%), “Areni Sev Clone №9” (18.17%), and “Nosr Areni” (17.22%). Notably, the lower the skeleton mass, the higher the proportion of pulp.

The cluster composition index is determined as the ratio of pulp plus juice to the skeleton mass. For the “Areni Sev” grape variety, the cluster composition index was 2.97; in “Nosr Areni”, it was nearly 1.6 times higher at 4.8; in “Areni Sev Clone №9”, it was 4.5, and in “Areni Sev Clone №15” - 4.3. This index varies depending on the grape variety. The higher the cluster composition index—that is, the ratio of pulp plus juice to skeleton mass—the juicier the grape, resulting in a higher yield.

Conclusion

According to the research, the cluster composition index of the “Areni Sev” grape variety and its clones is determined by the content of pulp and juice. The higher the ratio of pulp plus juice to skeleton mass, the greater the cluster composition index and, consequently, the higher the juice yield. The highest cluster composition index was recorded in the “Nosr Areni” clone (4.8), followed by “Areni Sev Clone №9” (4.5) and “Areni Sev Clone №15” (4.3), while the lowest index was observed in the parent “Areni Sev” variety (2.97).

Based on these results, the clones of “Areni Sev” can be successfully utilized in winemaking. The studied clones are promising for the production of high-quality wines, and further research is ongoing to fully explore their potential.

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