The object of research is wine samples obtained by maceration of seeded and seedless skins from the autochthonous Madrasa grape variety. The studies were conducted on the autochthonous Madrasa grape variety the influence of the mechanical composition of the bunch and the applied technological methods on the wine composition and quality indicators of wine was not been studied. For the four variants with different numbers of bunches stored in the tin, the amount of lactic juice in % was 83.85–86.03 %, the structural index was 5.2–6.2, and no big difference was noticed between the variants. The amount of phenolic compounds was higher in the fermentation of the pulp with the seed than without the seed. The amount of phenolic compounds was highest (1.87 gAE/L) during alcohol fermentation, and lowest (1.22 gAE/L) during the rest period. The amount of anthocyanins in peel maceration with seeds was 0.118 gMvd-3-0-glu/u, this amount was 0.137 gMvd-3-0-glu/u in fermentation without seeds. After alcohol fermentation, those indicators were 0.140 and 0.208 gMvd-3-0-glu/u, reaching the maximum, respectively. The samples obtained from the Madrasa grape variety, macerated for 48 and 96 hours, were divided into two parts, one of which was fermented with natural yeasts (TQ) and the other with cultured yeasts (MMQ). The amount of total phenolic compounds and phenolic acids in TQ was lower than that of MMQ samples, and the amount of aromatic compounds, on the contrary, was higher in naturally fermented than in samples fermented with cultured yeasts. These studies are important for production in terms of regulating the number of clusters stored in the barrel and the processes occurring during the stages of wine production. The obtained results can be used in family farms and wineries

Keywords: autochthonous, antioxidant activity, cluster, monomeric anthocyanins, residue, maceration, skin, pips

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IDENTIFYING THE INFLUENCE OF VARIOUS TECHNOLOGICAL TECHNIQUES ON THE INDICATORS OF THE COMPOSITION OF BUNCHES AND WINE SAMPLES OF THE MADRAS GRAPE VARIETY

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1. Introduction

It is undeniable that the road to quality wine starts from the vineyards. The number of bunches stored in the tin also has a special role in the quality of the product. This indicator can have different values depending on the grape variety, growing conditions and other factors. Depending on the number of bunches, the mechanical and physico-chemical composition of grapes can also change.

Maceration is a very important step in winemaking technology, especially in the production of red wines. During maceration, aromatic and flavor compounds, polyphenols, polysaccharides, nitrogenous, mineral compounds, anthocyanins, dyes and many other substances pass from the mash to the wine. In red grape varieties where the color substances are located in the skin, the rind is practically colorless. This means that the wine without maceration remains uncolored white. The duration of maceration affects the color intensity of the wine.

Alcoholic fermentation of grape must is the main process in winemaking, and the quality and stability of the obtained wine largely depends on its progress. The course of the fer-

mentation process depends on the yeast strain, temperature, aeration, the initial amount of various substances in the juice and the pH of the environment.

There are always yeasts on the surface of the grape skin, that is, on the skin. Wild yeasts represent many different and randomly assembled strains. In addition, they contain acetic acid bacteria and a large number of different fungi. Natural fermentation with the help of those endogenous or "wild" yeasts.

At the same time, pure solutions of cultured yeasts are used in the commercial production of wine. Many researchers support the idea that fermentation is carried out with yeast, others with conglomerates of yeast cells.

Based on the above, it is possible to note that the influence of the number of bunches stored in the barrel on its mechanical and physico-chemical composition, skin maceration with and without seeds in red grape varieties whose color substances are located in the skin, its duration and conditions, as well as the effect of the yeasts used in fermentation on the composition of the wine samples. dedicated studies are relevant.

2. Literature review and problem statement

The article [1] presents the results of the study of the effect of pruning on the mechanical composition of the bunch of three grape varieties. It is shown that the weight of the bunch, berry, comb and berry, the width of the berry was in variant II (Alphonse Laval variety), the longest bunch (in Black Macig variety) was in variant II, the largest bunch and longest berry were in variant III, and the most berries in one bunch were in variant II (Muscat Bleu variety). But there are still unresolved issues related to the analysis of the mechanical composition of grapes depending on the number of stored bunches.

In the studies [2], the profile of flavor compounds (amino acids, organic acids and volatile aromatic compounds) in pitted vampi wine during fermentation under optimal conditions was analyzed using high performance liquid chromatography and gas chromatography with mass spectrometry. A total of 54 tertiary components were detected, including esters, alcohols, terpenes and acids. It was shown that an increase in esters and a decrease in terpenes during fermentation can significantly change the taste of wine. These characteristics stimulate the further development of seedless vampi wine. However, the issues of fermentation with seeds remain unresolved. It is advisable to conduct a study on optimizing the fermentation conditions with and without seeds.

The article [3] presents the results of the influence of different fermentation strategies on the physicochemical properties of wine, the antioxidant activity of monomeric phenols and volatile compounds on yellow peach. It is shown that the fermented material differs in the total content of phenols, flavonoids, monomeric phenols, volatile compounds, and antioxidant activity. However, in this study, the above indicators were assessed in wine material, it would be appropriate to study the processes occurring during fermentation with and without stones.

Studies [4] have investigated the effect of fermentation temperature on the chemical composition, concentration of volatile aromatic compounds from yeasts, and quality of young red wines. The results of the study showed that combining warm maceration with low-temperature fermentation, and using cold-tolerant autochthonous yeast strains, results in red wines with improved organoleptic properties. Yeast strains were evaluated primarily in terms of temperature tolerance. A comparative study of natural and pure fermentation would be more appropriate.

The article [5] determined the concentration of different yeast strains, the fermentation characteristics and the aromatic profile of the resulting wine. It was found that cryoextraction and cold maceration before fermentation have a smaller effect on the aromatic profile than the yeasts involved in the fermentation process. However, the large number of factors does not allow for a complete assessment of the issue.

The effect of microwave treatment of grape crush on yeast populations in juice and the development of alcohol fermentation, as well as the separation of various compounds from grapes, including polysaccharides and amino acids, was studied. In this study, it was noted that the effects of microwaving grapes on native yeast species lead to an increase in fermentation kinetics and a decrease in the lag phase. It has been found that microwave treatment has a positive effect on the separation of amino acids and polysaccharides from grapes, the amount of essential amino acids in the grape must and the amount of some essential volatile compounds in the processed samples have been significantly increased [6]. The effect of microwave treatment on native yeasts, as well as positive effects on the extraction of some substances, does not reflect the issues raised in the current topic.

In the study [7], the evolution of bacterial populations was studied when wine was made using carbon dioxide maceration and without yeast inoculation. For this purpose, research is conducted in 3 directions: Spontaneous fermentation (without inoculation); With the addition of "Pied de cuve" technology and active dry yeasts. Each direction was compared in carbon dioxide maceration and the standard combing and crushing method. This research work, devoted to the development of bacterial populations in winemaking with carbon dioxide maceration and standard comb separation-crushing method, does not cover the issues studied in the current topic.

Research [8] has shown that maceration prior to fermentation has a positive effect on aroma and sensory profile. The best sensory value was obtained with C. famata WB-1 and wines fermented without maceration before fermentation and then macerated with M. pulcherrima B-5. M. pulcherrima B-5 and C. famata WB-1 have shown strong potential to improve the sensory and aromatic profile of Chardonnay wine. However, the effect of the shell and kernel on the composition and quality of the product was not investigated.

In the article [9], the physico-chemical characteristics of wines obtained with the help of sulfite maceration were studied and analyzed. For this purpose, the Alicante Gushe grape variety was used. Research was conducted in 3 directions. The grapes were destemmed, crushed, macerated for 2 days and juice fermented to remove SO_2 before fermentation.

Carbon dioxide maceration in the preparation of wine from Hamburg Muscat was studied in a comparative way with traditional methods. The result of the study showed that carbon dioxide maceration had the highest value of aroma activity and was evaluated with 86.8 points. Carbon dioxide maceration significantly improved the quality of Hamburg Muscat wine compared to other traditional methods [10].

The production of various wines from the autochthonous Madrasa grape variety in the Nagorno Shirvan region

of Azerbaijan was studied. Under these conditions, some factors influencing the optimal ripening period of grapes were investigated, and wines made from the same variety in 3 different colors were kept and grown in containers that differed in terms of material. At the same time, the effect of maceration temperature and duration on the quality of wines was studied [11, 12]. However, the change of the mechanical composition of the grapes depending on the number of bunches was not studied, and the effect of the solid elements of the clay during the maceration process on the quality of the future wine was not investigated.

From the above, it is clear that the mechanical composition of the bunch in the autochthonous Madrasa grape variety changes depending on the number of bunches stored in the vine. In autochthonous Madrasa grape variety, the role of the components that make up the skin (peel, seed, juice) in the winemaking process has not been sufficiently investigated. At the same time, whether these components are present or not, the effect of maceration with the addition of heat and enzyme preparations, as well as the yeasts used in fermentation on the composition of the future wine, has not been sufficiently investigated.

3. The aim and objectives of the study

The aim of the study is to identify the influence of technological techniques on mechanical composition of the Madrasa grape and wine quality.

To achieve this aim, the following objectives are accomplished:

– determining the mechanical composition indicators of bunch in Madrasa grape variety;

– investigation of phenolic compounds and antioxidant properties in wine samples obtained by skin maceration with and without seeds;

– study of changes in the amount of anthocyanins during the stages of winemaking;

– study of the effect of maceration time and yeast on the physicochemical properties of wine samples.

4. Materials and methods

Wine samples obtained by maceration of seeded and seedless skins from the autochthonous Madrasa grape variety were taken as the object of research.

The main idea of the study is to determine the optimal number of bunches stored in a barrel in the foothills of the autochthonous Madrasa grape variety, to study the maceration of the solid parts of the grape (seeds and skins) with grape juice together or separately, as well as the transformations that occur from them at different stages of winemaking. At the same time, it is to investigate the effect of natural and cultural yeasts, as well as the maceration time on quality. The application of modern analysis methods greatly simplifies the issues in the research.

The analysis of the constituent indicators of the wine samples is carried out depending on the solid parts of the grape (core and skin), as well as the applied methods of influence (fermenting, heat effect). Physico-chemical and organoleptic indicators of raw materials, semi-finished products and finished products are determined by general analysis methods available in enochemistry [14]. However, modern analysis methods were used in the work, including High Performance Liquid Chromatography (HPLC), the widely used DPPH method for capturing free radicals, computer techniques for statistical processing of data, and Statistica 6.0 SPSS Statistics 17.0 package program.

Mass concentration of phenolic compounds in wine was determined by the Folin-Chocalteu method. Adding Folin-Chocalteu reagent to wine oxidizes phenolic groups and reduces them to a blue colored compound. In this case, the intensity of the color is proportional to the concentration of phenolic compounds.

Agilent-1100 brand HPLC with double pump, double wavelength and diode array detector was used for the detection of anthocyanins. 6 ml of the juice or wine to be analyzed was passed through an LC-18 superelecan cartridge and resination of anthocyanins was carried out in this way. Then, 18 ml H_2O-HCC (99.9/0.1; v/v) was passed through the cartridge to remove sugars in the medium. At the same time, 12 ml of McOH-HCl (99.9/0.1; v/v) were added to this solvent. After mixing the anthocyanins with the solvent, the resulting mixture was concentrated to dryness in an evaporator at 25 °C. After that, the anthocyanins stuck to the wall of the evaporator flask were dissolved in 1 ml of methyl alcohol/water/formic acid (40/55/5:v/v/v) solvent and injected into HPLC, and the amount and profiles of anthocyanins were determined. The profiles of anthocyanins were revealed by directly injecting pre-regulated peel extractors. HPLC-MS is used in the identification of anthocyanin compounds. Delphinidin, cyanidin, petunidin, peonidin and malvidin-3-glycoside standards were used to detect the amount of anthocyanins. For each standard, a solution of five different concentrations was prepared and injected into the HPLC, calibration curves were established, and the amount of compounds was determined by calculation based on the obtained curves.

2,2-diphenyl-1-picrylhydrazyl (DPPH) radical is one of the oldest radicals used to determine the activity of phenol antioxidants:

$$DPPH+AH \rightarrow DPPH-H+A-.$$

According to the above reaction, antioxidants donate hydrogen to the DPPH radical. The duration of this test can vary from 10 minutes to 6 hours. This method is used to determine the antiradical effect of polyphenolic compounds. The use of the DPPH method is limited. Because DPPH radicals interact with other radicals and the time it takes for DPPH radicals to reach a steady state affects its accuracy.

Hunterlab (Model D-9000 Color Difference Meter) analyzer was used to measure the color of wine samples. In Hunter, a-value measures redness and greenness, and b-value measures yellowness and blueness. The L-value measures the degree of light or brightness. The price varies between 100 – full white, 0-black.

In Madrasa grape variety, the mechanical composition of the cluster was studied in four variants depending on the load given to the stem per cluster. I–8; II–12; the mechanical composition of the bunches was studied by taking samples from the vineyards where bunches III–16 and IV–20 were kept. For this purpose, the methodology of N. N. Prostoserdov is used. The weight, length, width of a cluster, the weight, length, width, etc. of a bushel. is determined.

Preparation of wine samples is carried out by applying different technologies depending on the presence or absence

of solid elements of the clay (rind and seeds), as well as enzyme preparations and heat treatment. By adding Rohavin VR-c pectolytic enzyme preparation (3 g/hl), phenolic compounds and antioxidant activity are studied in mash fermentation, alcohol fermentation, resting, rinsing and storage operations.

Statistical analyses were performed using the SPSS18 package [14, 15].

As a result of the research, the change in the mechanical composition of the grape bunch depending on the number of bunches stored in the barrel in the autochthonous Madrasa grape variety will be studied, the role played by the components that make up the grape (skin, seeds, pulp juice) in the winemaking process; their participation or absence, the effect of maceration with the addition of heat and enzyme preparations, as well as the yeasts used in fermentation on the composition of the future wine will be determined.

5. Results of the study of the influence of the preparation method on the composition and quality of wine samples

5. 1. Determining the mechanical composition indicators of bunch in Madrasa grape variety

The structure, composition and structure of the cluster in the studied Madrasa grape variety were compared. The structure of the bunch is characterized by the average mass of the bunch, the number of gills, the mass and percentage of gills and comb in the bunch, and the ratio of the gill mass to the comb mass (Table 1).

Table 1

The effect of the number of bunches stored in the tin on the bunch structure in Madrasa variety $n=6$, $p<0.05$

Variants	The average mass of a bunch, g	The number of berries in a bunch, number	Mass, g		Mass, in %		Structure indicator
			Berry	Comb	Berry	Comb	
I	178	108	171.5	6.2	96.30	3.48	27.66
II	168	103	162.0	6.0	96.42	3.57	27.00
III	163	104	156.5	6.5	96.01	3.98	24.07
IV	158	102	151.6	6.4	95.94	4.05	23.68

As it can be seen, as the number of bunches stored in the tin increased, the structural index decreased, the highest (27.66) index was in option I, the least was in option IV (23.68) and it was optimal in option II.

The aggregate (total) mass of the bunch is characterized by the mass of 100 grains and 100 seeds, the number of seeds in 100 grains, the mass of seeds, peel and juice in 100 grains, the total indicator of the bunch (the ratio of the mass of the pulp with juice to the mass of the peel). The total (summary) of the cluster is given (Table 2).

As it is known, one of the important indicators in technical grape varieties is the aggregate of bunches. More number and mass of gills are observed in large bunches and less in small bunches.

As it can be seen, the largest mass of seeds in 100 grapes was observed when 20 bunches were stored on the vine, and the largest mass of husk was observed in the variants where 16 bunches were stored on the vine.

Table 2

Summary of the selection of variants in the Madrasa grape variety $n=6$, $p<0.05$

Variants	Mass, g		Amount of seeds in 100 grape berries, pcs	Weight of 100 grapes, g			Final indicator
	100 grapes	100 grape seeds		Seed	Skin	Pulp with juice	
I	164	3.0	193	5.79	12.04	145.81	12.11
II	163	3.1	192	5.95	11.13	145.92	13.11
III	156	3.0	196	5.88	13.21	136.91	10.36
IV	154	3.2	198	6.33	12.45	135.22	10.86

However, in the processing of grapes, the percentage of comb and gills in the bunch is important. According to the studied options, the amount of comb in clusters varies from 3.48 to 4.05. At this time, the lowest indicator was observed in the first option, and higher indicators were observed in the last options.

According to the investigated variants, the amount of berries in the bunch fluctuated between 95.94–96.42. As it is possible to see, there is not much difference between the options.

The ratio of the mass of the gill to the mass of the comb (an indicator of the structure of the cluster) was the best in the first variant (27.66), and the lowest in the last variant, that is, when 20 clusters were stored in the tin (23.68).

By the structure of the bunch of grapes, it is understood the expression of the component parts of the bunch – comb, skin, seeds, lath, solid residue (the sum of comb, skin, seeds) in %. In addition, clay and structural indicators are also determined.

The structural indicators of the cluster for the studied options are given below (Table 3).

Table 3

Structure of the cluster according to the variants studied $n=6$, $p<0.05$

Variants	In the bunch, in %					Indicators	
	Comb	Skin	Seed	Solid residue	Pulp with juice	Berry	Structure
I	3.48	7.5	3.5	14.48	85.52	60.7	5.9
II	3.57	6.8	3.6	13.97	86.03	61.3	6.2
III	3.98	8.4	3.6	15.98	84.02	63.8	5.3
IV	4.05	8.0	4.1	16.15	83.85	64.5	5.2

As it can be seen, there is no significant difference between the variants in terms of % and amount of comb in the cluster. The least amount of comb (3.48 %) was observed in the first variant, where 8 bunches were kept in the tin, and with the increase in the number of bunches, a slight increase in this amount was noticed. In the last variant, a higher amount of comb (4.05 %) was found compared to the others.

The amount of seeds in the bunch varied between 3.5–4.1 % for the investigated variants.

As it is known, the most important factor for the structure of the bunch in technical grape varieties is the amount of lactic juice in %. According to that indicator, the second option with 86.03 %, that is, the option of keeping 12 bunches in a tin, was in the first place. After that came the first, third and finally the fourth option.

The number of berries per 100 g bunch (berry index) fluctuated between 60.7–64.5 for the studied variants.

The mass share with latin juice was a more valuable indicator for the studied options from a technical point of view, and varied between 83.85–86.03 %.

For technical varieties, the ratio of the mass of the juicy pulp to the mass of the solid residue in the bunch (structural indicator) is important. The higher this indicator is, the higher the juice yield is when the grapes are pressed directly. If to look at the results of the options, it is clear that this indicator was higher in the second and first options, and relatively lower in the other options. However, it should be noted that the difference between the options is not very big. In general, the structural index fluctuated between 5.2–6.2. That is, it is noticeable that there is a difference of 1.0 between the highest and the lowest option.

The gila index is determined by the number of gila in 100 g of gila, and the structural indicator is determined by the ratio of the mass of the latin to the mass of the skeleton (solid residue).

The yield per bunch and per hectare was determined depending on the amount of load given per bunch in the Madrasa grape variety. When 8 bunches were stored, 1.4 kg of product was obtained from one bunch, and 3707.2 kg from 1 hectare. As the number of bunches increased in the variants, a corresponding increase in the yield per bunch and per hectare was also noticeable. Thus, in the second variant, where 12 bunches were stored, 2.0 kg of product was obtained from one bunch, and 5575.8 kg from 1 ha; in the third variant, where 16 bunches were stored, 2.6 kg of product was obtained from one bunch, and 6954.4 kg from 1 ha; in the fourth variant, where 20 bunches were stored, 3.2 kg of product was obtained from one bunch, and 8426.4 kg from 1 ha.

Wine samples were prepared from the Madrasa grape variety according to the experimental variants using the traditional method. In the wine samples obtained, the alcohol content ranged between 11.4–12.1 % vol., the extracted extract ranged between 18.7–23.4 g/dm^3 and the residual extract ranged between 14.2–19.2 g/dm^3. As the number of clusters in the barrel increased, the amount of extractive substances and alcohol tended to decrease. Organoleptic analysis complemented the results of the physical-chemical analysis. It is noticeable that the first variant stood out with the highest score. This variant was rated 0.4 points higher than the last. As the number of clusters stored in the barrel increased, a deterioration in the quality of the wine was observed compared to the previous ones.

5. 2. Phenolic compounds and antioxidant property in wine samples obtained by maceration of skins with and without seeds investigation

The effect of the structural parts of the grape, including the pith, on the composition of the obtained wine was investigated. The amount of phenolic compounds and antioxidant activity were studied in the samples obtained from the fermentation of grape pomace with and without seeds (Fig. 1–3).

The amount of phenolic compounds was higher in the fermentation of the pulp with seeds than without seeds. Among the applied operations, the total phenolic compounds had the highest amount (1.87 gAE/L) during the alcohol fermentation, while the difference in the amount of total phenolic compounds was not noticeable in the stages of fermentation, rinsing and storage. However, it was characterized by the lowest value (1.22 gAE/L) during the rest period. A similar situation was observed in natural fermentation carried out without seeds, the highest value was obtained during alcohol fermentation, and the lowest value was obtained during storage

As can be seen, the amount of flavonoids was 1.59 g Catechin/L during maceration of seed and peel, and it tended to decrease in subsequent technological operations. The greatest reduction was observed during rinsing and storage. Although the amount of flavonoids was 0.91 g Catechin/L during maceration of seedless husks, it increased by 1.01 g Catechin/L during alcohol fermentation and 1.31 g Catechin/L during rest, and in further technological operations, i.e., 0.80 g Catechin during rinsing. /L and showed a reduction of 0.11 g Catechin/L in retention.

The antioxidant index was 57.61 mg/l in pith and peel maceration, which showed a decrease in alcohol fermentation and rest, an increase in rinsing, and finally a decrease in storage. A similar situation was observed in the maceration of the shell without the seed.

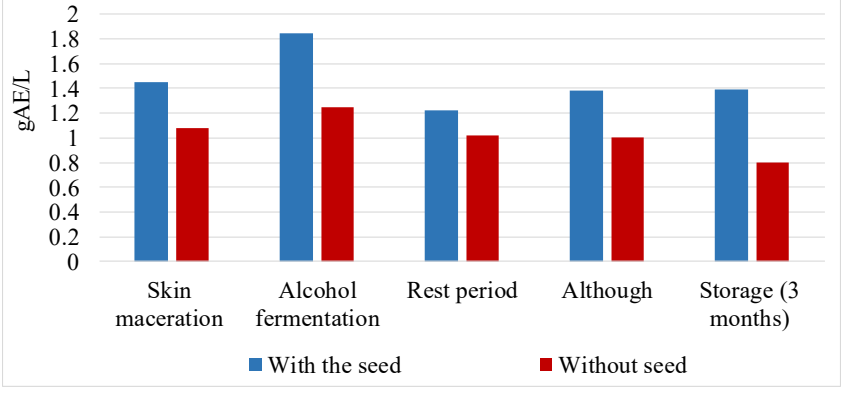

Fig. 1. Effect of various technological operations on the amount of phenolic compounds, $n=6$, $p<0.05$

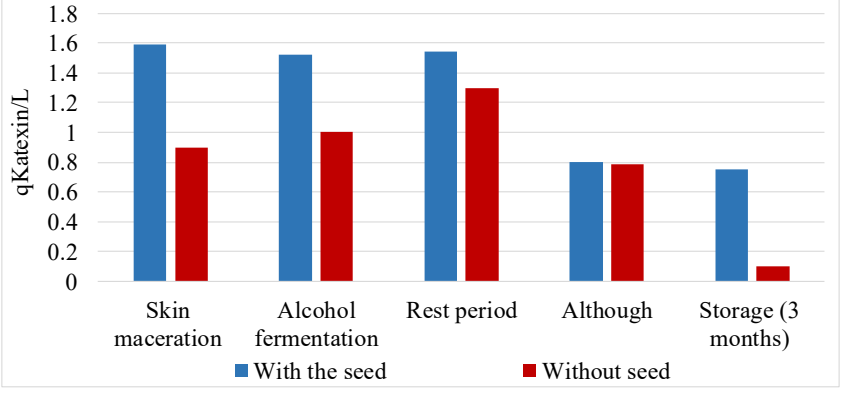

Fig. 2. Effect of various technological operations on the amount of flavonoids, $n=6$, $p<0.05$

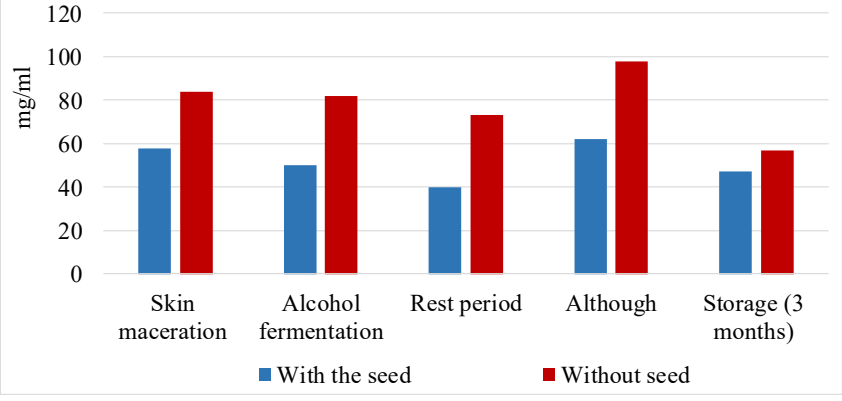

Fig. 3. Effect of different technological operations on antioxidant activity (DPPH, EC50 amount), $n=6$, $p<0.05$

As an enzyme preparation (FP), Saceharomyces bcerevisiac subsp. Using Rohavin VR-c pectolytic (3 g/hl) enzyme preparation as an addition to NRRL-Y 16232 yeast, phenolic compounds and antioxidant activity were studied during fermentation, alcohol fermentation, resting, rinsing and storage operations in the mash (Table 4).

As it can be seen, the amount of phenolic compounds was higher during bark fermentation and decreased due to this in other processes. The lowest amount of phenolic compounds was observed after rinsing. As for the amount of flavonoids, on the contrary, its amount was low during fermentation in the peel, and increased during subsequent processes. The amount of anthocyanins increased after alcohol fermentation compared to peel maceration and was observed to decrease again in subsequent processes. Although the antioxidant activity was relatively high during peel maceration, it decreased after alcohol fermentation and resting, but a trend towards increase was observed in the subsequent operations and it received a relatively high value after storage.

The amount of flavonoids was 1.30 g Catechin/L in seed shell maceration, 1.87 Catechin/L during alcohol fermentation, 1.86 Catechin/L in resting, 1.73 Catechin/L in rinsing, and 1.89 Catechin/L in storage. As it can be seen, an increase in the amount of flavonoids by technological stages was noticed.

The effect of different processes was also studied in the seedless pulp with the addition of enzyme preparation (Table 5).

It was found that the amount of phenolic compounds, flavonoids, and anthocyanins was much less compared to experimental samples with seeds. The main point of interest is that in this series of experiments, the antioxidant capacity is slightly higher than the previous one and shows a difference between operations.

Unlike the classic maceration, before fermentation, the mash was heated at 65 °C and macerated. Changes in phenolic compounds and antioxidant activity were observed according to operations (Tables 6, 7).

Table 4

Effect of technological operations on phenolic compounds and antioxidant activity in the crushed seed with enzyme preparation, $n=6$, $p<0.05$

Indicators	Acquisition processes				
	Seeded husk maceration with the addition of FP	Alcohol fermentation	Rest period	Although	Storage
Phenolic compounds, qGAE/L	1.93	1.42	1.44	1.40	1.46
Flavonoids, qCatechin/L	1.30	1.87	1.86	1.73	1.89
Anthocyanins, qMvd-3-0-glu/u	0.091	0.20	0.017	0.046	0.047
DPPH EC50, mg/ml	51.30	44.90	45.00	51.70	53.60

Table 5

Effects of different processes on phenolic compounds and antioxidant activity in seedless crushing with enzyme preparation, $n=6$, $p<0.05$

Indicators	Acquisition processes				
	Seedless peel maceration with the addition of FP	Alcohol fermentation	Rest period	Although	Storage
Phenolic compounds, qGAE/L	1.40	1.01	0.99	0.78	0.75
Flavonoids, qCatechin/L	1.21	1.35	1.80	1.34	1.89
Anthocyanins, qMvd-3-0-glu/u	0.074	0.074	0.029	0.05	0.019
DPPH EC50, mg/ml	91.66	74.21	74.31	111.76	88.16

Table 6

Effects of different processes on phenolic compounds and antioxidant activity in heat-treated seed mash, $n=6$, $p<0.05$

Indicators	Acquisition processes				
	Hot maceration of mash with seeded husk	Alcohol fermentation	Rest period	Although	Storage
Phenolic compounds, qGAE/L	2.71	1.77	1.82	1.17	1.08
Flavonoids, qCatechin/L	5.96	5.47	4.47	3.90	3.36
Anthocyanins, qMvd-3-0-glu/u	0.058	0.095	0.083	0.059	0.044
DPPH EC50, mg/ml	50.21	29.01	47.01	39.94	36.64

Table 7

Effects of different processes on phenolic compounds and antioxidant activity in heat-treated seedless pulp, $n=6$, $p<0.05$

Indicators	Acquisition processes				
	Hot maceration of mash with seedless peel	Alcohol fermentation	Rest period	Although	Storage
Phenolic compounds, qGAE/L	2.21	1.08	1.18	1.03	0.96
Flavonoids, qCatechin/L	3.65	3.05	3.02	2.82	2.25
Anthocyanins, qMvd-3-0-glu/u	0.0202	0.0557	0.0545	0.0475	0.0251
DPPH EC50, mg/ml	72.00	51.98	57.63	41.94	42.01

The amount of phenolic compounds during heat treatment of pulp with seeds was much higher than heat treatment of pulp without seeds. If in the first case the phenolic compounds were 2.71 gAE/L during the maceration of the peel, it was 2.21 gAE/L during the heat treatment of the seedless pulp. If to look at the amount of flavonoids, it is possible to see a regularity in this indicator as well. In antioxidant activity (DPPH EC50), let's witness a different picture. So, this indicator was much less than the second one in the first series of experiments, i.e. in operations with the core. A look at the operational indicators shows some kind of consistency in both cases. A reduction of phenolic compounds is observed in the process without core. This decrease is more noticeable during alcohol fermentation with a slight increase in later operations. Although there are fluctuations in the amount of flavonoids, there is generally a tendency towards a decrease in the last operations. Antioxidant activity in both cases significantly decreased in alcohol fermentation, increased in resting; demonstrated by a decrease in flushing and retention.

5. 3. Study of changes in the amount of anthocyanins during the stages of winemaking

The amount of anthocyanins was studied at the stages of wine preparation with maceration with and without seeds (Fig. 4).

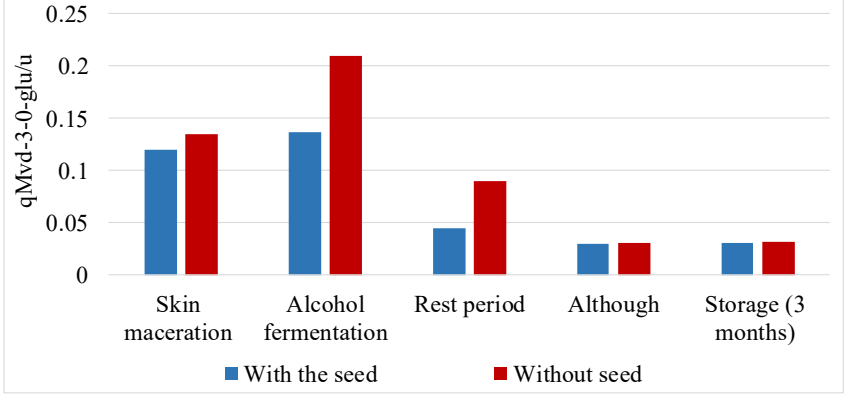

Fig. 4. Amount of anthocyanins during different technological operations, $n=6$, $p<0.05$

It was determined that the amount of anthocyanins in fermentation with seed and peel maceration was 0.118 gMvd-3-0-glu/u, while in fermentation without seed, this amount was 0.137 gMvd-3-0-glu/u. Looking at the stages of winemaking, it is clear that after alcohol fermentation, those indicators reached their maximum and were 0.140 and 0.208 gMvd-3-0-glu/u, respectively. The amount of anthocyanins significantly decreased during the resting of the samples, and the decrease continued during the rinsing stage. Although it was accompanied by a kind of stabilization in storage.

Phenolic acids – hal, protocatechin, chlorogenic, p-coumaric and ferulic acids and flavanol derivatives – catechin, (–)-epicatechin, (–)-epigallocatechin were detected in the wine samples taken at the end of the fermentation operations during the analysis by high-density liquid chromatography (HDLC). has been done. Phenolic acids and anthocyanins were the main compounds in the samples obtained during seedless fermentation, and catechin and its derivatives in the seed fermentation. Chromatograms obtained from analyzes carried out by YQMX are provided (Fig. 5, 6).

The chromatogram of monomeric anthocyanins in wine samples obtained by seedless fermentation was as follows (Fig. 7).

Malvinidin-3-glucoside was found to be the main compound during the analysis of the wine sample obtained from the Madrasa grape variety, peonidin, malvinidine, aglycones were detected.

Changes in monomeric anthocyanins were investigated in the study. In particular, it was found that monomeric anthocyanins were completely converted into polymeric compounds in the studied samples after 6 months of storage, starting from resting the samples. The polymer compounds appeared undissociated near the malvinidine peak at 520 nm wavelength.

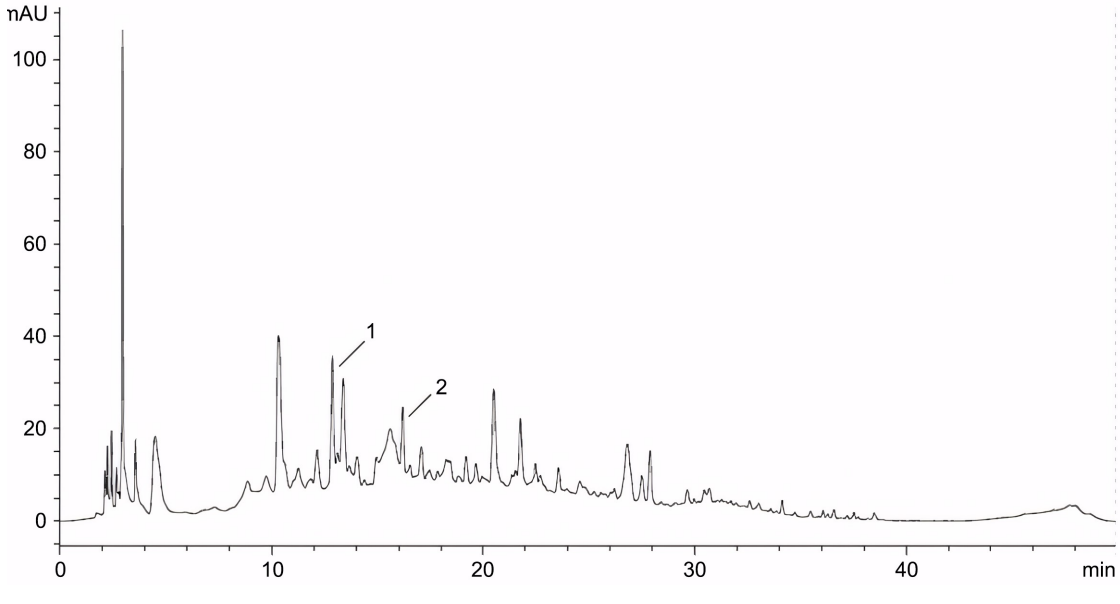

Fig. 5. A sample of wine obtained by maceration with grapes chromatogram: 1 – catechin; 2 – epicatechin

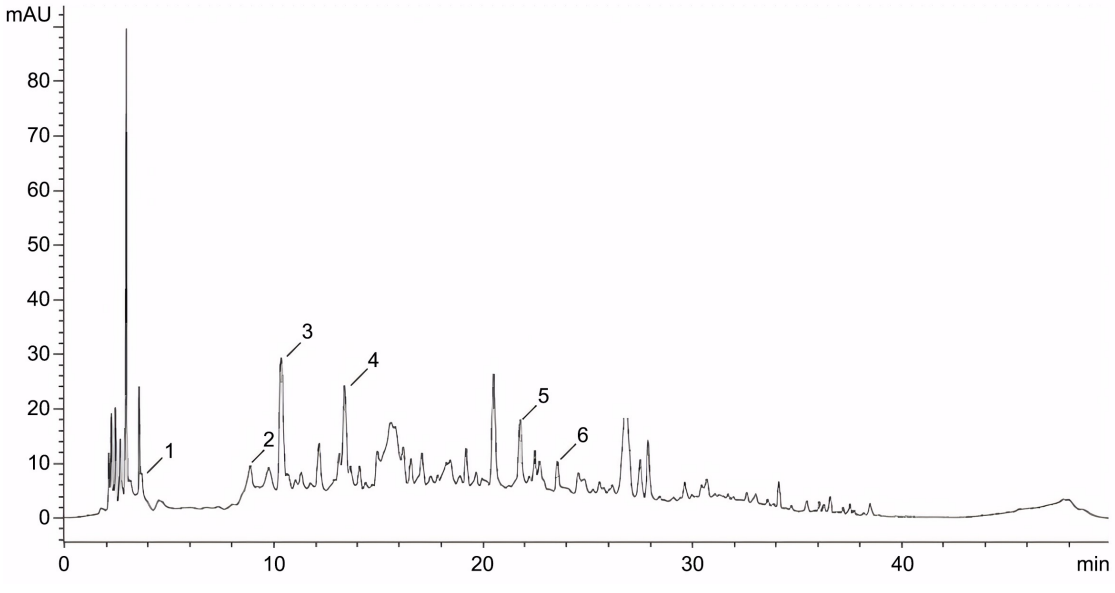

Fig. 6. Wine sample obtained by maceration without seeds: Chromatogram: 1 — Hal acid; 2 — Protocatechinic acid; 3 — Hydroxycinnamic acid derivative; 4 — Chlorogenic acid; 5 — Paracoumaric acid, 6 — ferulic acid

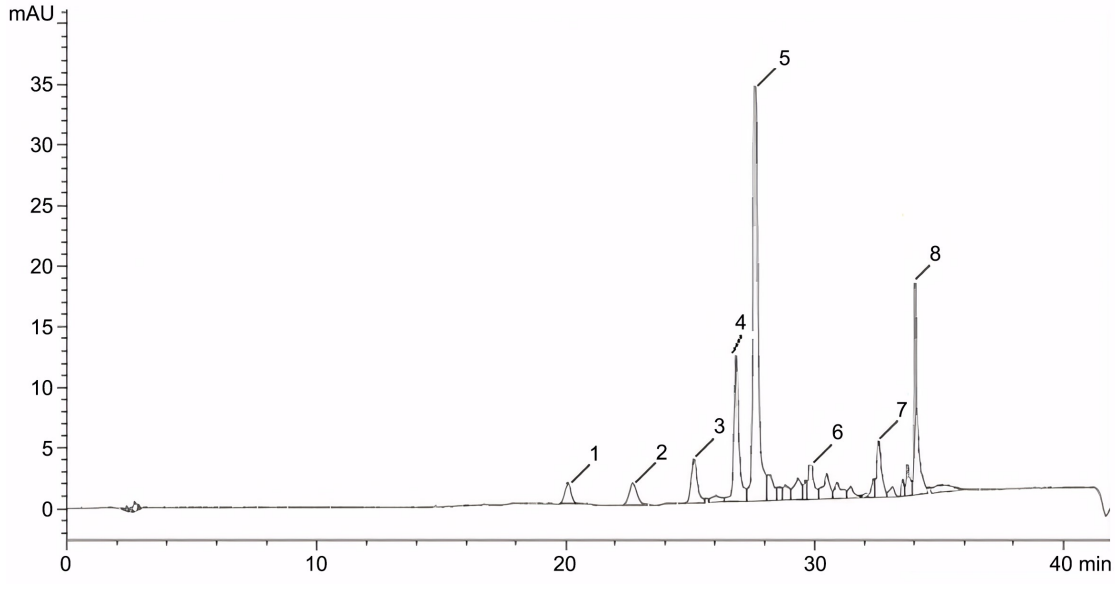

Fig. 7. In the example of wine made by maceration without seeds chromatogram of monomeric anthocyanins: 1 — delphinidin-3-glucoside (Df-3-glu); 2 — cyanidin-3-glucoside (Cyn-3-glu); 3 — peonidin-3-glucoside (Pn-3-glu); 4 — petunidin-3-glucoside (Pt-3-glu); 5 — malvidin-3-glucoside (Mvn-3-glu); 6 — cyanidin (Cyn); 7 — peonidin (Pn); 8 — malvinidine (Mvn))

5. 4. Study of the effect of maceration time and yeasts on the physico-chemical properties of wine samples

Madrasa grape was macerated for 48 hours and 96 hours in the crush. The juices, which were macerated separately for 48 and 96 hours, were divided into two parts, one of which was fermented with natural (TQ) and the other with cultured yeasts (MMQ). After fermentation, physico-chemical analyzes of the samples were carried out (Table 8).

As can be seen, the amount of titratable acids was 6.09 g/dm^3 in samples macerated for 48 hours and naturally fermented, and 6.04 g/dm^3 in samples fermented with cultured yeasts. In samples macerated for 96 hours, this indicator was 6.18 g/dm^3 and 6.15 g/dm^3, respectively. The amount of free SO_2 in all wine samples varied between 12.42–13.22 mg/dm^3, and the amount of total SO_2 varied between 17.17–18.14 mg/dm^3. The darkness of the samples fluctuated between 9.98–10.20 h %. The amount of volatile acids was 0.20–0.31 g/dm^3 within the norm.

Table 8

Physico-chemical composition indicators of wine samples, $n=6$, $p<0.05$

Physico-chemical indicators	Method of purchase			
	TQ 48	MMQ 48	TQ 96	MMQ 96
pH	3.25	3.24	3.31	3.33
Titratable acidity, g/dm^3	6.09	6.04	6.18	6.15
Free SO_2, mq/dm^3	12.51	12.42	13.05	13.22
Total SO_2, mq/dm^3	17.76	17.43	17.17	18.14
Residual sugar, q/dm^3	1.94	1.86	1.03	1.21
Alcohol, h %	10.01	9.98	10.20	10.04
Volatile acidity, q/dm^3	0.20	0.26	0.22	0.31

Color indicators of wine samples after maceration and fermentation were analyzed (Tables 9, 10).

Table 9

Color indicators of samples after maceration, $n=6$, $p<0.05$

Color indicators	Method of purchase			
	TQ 48	MMQ 48	TQ 96	MMQ 96
L	20.34	21.05	18.90	18.48
A	4.72	4.91	2.94	2.91
B	2.01	2.38	1.85	1.93

After 48 hours of maceration, the value of L in the samples varied from 20.34 to 21.05. After 96 hours of maceration, a slight decrease in L value was observed, its value fluctuated between 18.48 and 18.90. Looking at the value of a, it was found that this indicator is much lower in 96-hour maceration than in 48-hour maceration. A similar situation was observed in b values.

Table 10

Color indicators of the samples after fermentation, $n=6$, $p<0.05$

Color indicators	Method of purchase			
	TQ 48	MMQ 48	TQ 96	MMQ 96
L	17.70	17.98	17.22	18.03
A	2.18	1.94	0.98	1.17
B	1.82	1.60	1.33	1.24

As it can be seen, the color indicators of the samples after fermentation were characterized by slightly lower values than before. So, at this time, *L* values varied between 17.22–18.03, *a* values between 0.98–2.15 and *b* values between 1.24–1.82.

The amount of phenolic compounds after maceration and fermentation in experimental samples was studied (Table 11).

Table 11

Amount of total and monomeric phenolic compounds in wine samples, $n=6$, $p<0.05$

Indicators	Method of purchase			
	TQ 48	MMQ 48	TQ 96	MMQ 96
After maceration:				
Phenolic compounds, qGAE/L	1104	1070	1342	1630
Monomeric anthocyanins, mg mv-3-glu/L	79.18	65.42	85.36	86.01
After fermentation:				
Phenolic compounds, qGAE/L	1092	1112	1236	1560
Monomeric anthocyanins, mg mv-3-glu/L	66.22	63.48	70.18	72.41

It is clear from the Table 11 that the amount of total phenol compounds in the samples after maceration was 1104 gAE/L, 1070 gAE/L and 1630 gAE/L, respectively. It was found that an increase in the total amount of phenolic compounds was observed after 96 hours of maceration compared to 48 hours of maceration.

Looking at the total amount of phenolic compounds after fermentation, it is clear that in this case, the amount of phenolic compounds significantly decreased compared to the previous one. This can be attributed to the precipitation and conversion of phenolic compounds during fermentation. The amount of monomeric anthocyanins varied between 65.42–86.01 mg mv-3-glu/L after maceration, while this indicator varied between 63.48–72.41 mg mv-3-glu/L after fermentation. If to take a comparative look, it is possible to see that the amount of monomeric anthocyanins is higher after maceration.

Changes in the amount of phenolic acids in experimental samples were also observed with interesting results (Table 12).

Table 12

Amount of phenolic acids in wine samples, mg/l, $n=6$, $p<0.05$

Indicators	Operations	Method of purchase			
		TQ 48	MMQ 48	TQ 96	MMQ 96
Quinic acid	After maceration	66.05	58.21	41.22	36.93
	After fermentation	34.22	36.01	35.01	33.46
Halic acid	After maceration	4.36	3.92	8.16	8.23
	After fermentation	7.13	8.03	17.09	17.34
Coffee acid	After maceration	0.46	0.51	0.72	0.85
	After fermentation	1.88	1.81	1.98	2.01
Ferulic acid	After maceration	0.55	0.57	0.65	0.77
	After fermentation	0.37	0.82	0.35	0.94
p–kumar	After maceration	–	–	0.03	–
	After fermentation	0.76	1.16	0.70	1.41
Vanilla	After maceration	–	–	–	–
	After fermentation	–	–	–	–
(+)-catechin	After maceration	4.03	3.91	14.5	19.3
	After fermentation	7.32	8.15	18.62	19.94

As it can be seen, among phenolic acids, quinic acid stood out with its higher amount. The amount of quinic acid in the samples after maceration was between 36.93–66.05 mg/l. At this time, the highest value was observed after 48 hours of maceration. After fermentation, there was a decrease in the amount of this ink in the samples.

After quinic acid, it appears that halic acid and (+)-catechin have a superior position over other acids in terms of quantity. While the amount of halic acid was 4.36–8.23 mg/l in the samples after maceration, it showed an increase and fluctuated between 7.13–17.34 mg/l after fermentation. A similar situation was observed in the amount of (+) catechin, i. e., its increase occurred in the samples after fermentation.

The amount of aromatic compounds in wine samples fermented with different maceration periods and yeasts was studied (Table 13).

Table 13

Amount of aroma compounds in samples after fermentation, in %, $n=6$, $p<0.05$

Aromatic compounds	Examples			
	MMQ48	TQ48	MMQ96	TQ96
1-butylone, 3-methyl	1.02	1.17	8.6	13.4
2,3-butanediol	21.65	15.44	24.01	19.70
1,2,3-propanediol	0.31	0.34	–	–
1,2-propanediol	0.44	3.17	4.95	2.55
1,2,3-propanetriol	32.15	26.30	11.10	–
Glycerin	35.04	40.71	45.80	68.52
Acetic acid	–	1.31	3.75	3.86
Benzene ethanol	1.26	1.65	4.12	5.16
2-propanone, 1-hydroxy	–	2.76	6.40	6.01
Cis-5-hydroxy-2-methyl-1,3-dioxane	0.36	1.22	1.09	0.99
Trans-4-hydroxymeth-yl-2-methyl-1,3-dioxolane	–	0.65	0.5	–
Cis-4-hydroxymeth-yl-2-methyl-1,3-dioxolane	–	–	1.96	1.27
Propylene Glycidol	2.21	–	–	1.35
Glycidal	–	–	0.02	–

Apparently, between 10 and 14 aroma compounds were detected in the wine samples, depending on the variants. Glycerin (35.04 %), 1,2,3-propontrol (32.15 %), and 2,3-butanediol (21.35 %) were the most abundant aromatic compounds in wine samples fermented with cultured yeasts after 48 hours of maceration. In the TQ48 sample, glycerol (40.71 %), 1,2,3-propanetriol (26.30 %) and 2,3-butanediol (15.44 %) were ranked in order.

If to look at the MMQ96 sample, it is ranked in descending order of glycerol (45.80 %), 2,3-butanediol (24.01 %) and 1-butanol, 3-methyl (8.6 %). Although the dominance of those compounds was maintained in the samples of TQ96, differences in their quantity ratios were noticeable. Thus, in these ten samples, glycerin (68.52 %), 2,3-butanediol (19.70 %) and 1-butanol, 3-methyl (13.4 %) were present.

6. Discussion of the results of the influence of technological methods on the indicators of grapes and the wine composition in Madras grapes

The influence of the change in the number of bunches stored in the tin on the mechanical composition of the grape was studied and more rational options were determined. Bark maceration with and without seeds was performed with and without enzyme preparations and heat application. Changes in phenolic compounds and antioxidant properties were studied after the fermentation, resting, rinsing and storage processes of the samples. At the same time, the effect of maceration time and yeasts (pure yeast solutions and spontaneous fermentation) on the physico-chemical composition indicators of wine samples was investigated, and the color values, phenolic compounds, monomeric anthocyanins, and phenolic acid content of the samples were studied after maceration and fermentation. The amount of aromatic compounds in wine samples fermented with different maceration periods and yeasts was studied. As it can be seen, this research work, reflecting the application of various technological methods starting from raw materials and the change of phenolic compounds and antioxidant properties in successive stages of winemaking, is aimed at solving complex issues.

Unlike the research work [1], which was related to the change in the size of the cluster depending on the pruning length and the number of retained buds, this study studied the change in the mechanical composition of the grape depending on the number of bunches retained. It was found that in the Madrasa grape variety, as the number of bunches retained on the vine increased, the structural index decreased, in this case, the highest (27.66) index was in variant I, and the lowest in variant IV (23.68), and variant II was more rational (Table 1).

The number of combs in the cluster varies between 3.48–4.05 across the variants, with the lowest indicator observed in the first variant and higher indicators in the last variants. The ratio of the mass of the gill to the mass of the comb (an indicator of the structure of the cluster) was the best in the first variant (27.66), and the lowest in the last variant, that is, when 20 clusters were stored in the vine (23.68) (Table 2).

In technical grape varieties, the second option with 86.03 %, i. e., the option of keeping 12 bunches in a vine, was in the first place according to the amount of juice in %, which is considered the most important for the structure of the bunch. After that, the first, third and finally the fourth variant came. The structural index fluctuated between 5.2–6.2 (Table 3).

When 8 clusters were stored in the Madrasa grape variety, 1.4 kg of yield was obtained from one cluster, and 3707.2 kg from 1 hectare. As the number of clusters increased in the variants, a corresponding increase was noted in the yield obtained from one cluster and per hectare. Thus, in the second variant, where 12 clusters were stored, 2.0 kg of yield was obtained from one cluster, and 5575.8 kg from 1 ha; in the third variant, where 16 clusters were stored, 2.6 kg of yield was obtained from one cluster, and 6954.4 kg from 1 ha; in the fourth variant, where 20 clusters were stored, 3.2 kg of yield was obtained from one cluster, and 8426.4 kg from 1 ha.

In the samples of wine obtained from the Madrasa grape variety by the traditional method, the alcohol content varied between 11.4–12.1 %, the extracted extract between 18.7–23.4 g/dm^3 and the residual extract between 14.2–19.2 g/dm^3. As the number of clusters in the barrel increased, the amount of extract substances and alcohol tended to decrease. During the organoleptic analysis, the first variant was rated 0.4 points higher than the last. As the number of clusters stored in the barrel increased, a deterioration in the quality of the wine was observed compared to the previous ones.

Unlike previous studies that investigated the profile of flavor compounds in seedless fermentation [2] and evaluated phenolic compounds, antioxidant activity, and other indicators in wine material fermented with lees [3], this study comparatively analyzed the compositional indicators in both seeded and seedless fermentations.

The investigation of phenolic compounds and antioxidant properties in wine samples obtained by seeded and seedless skin maceration showed that the amount of phenolic compounds was higher in the fermentation of the mash with seeds than in the seedless one. While there was no significant difference in the amount of total phenolic compounds during the fermentation, settling and storage

stages of the applied operations, it had the highest amount during alcoholic fermentation (1.87 gGAE/L). However, it was characterized by the lowest value (1.22 gGAE/L) during the rest period. A similar situation was observed in the natural fermentation without kernels, the highest value was observed during alcoholic fermentation, and the lowest value was observed during storage (Fig. 1).

The amount of flavonoids was 1.59 g Catechin/L during the maceration of the shell with the kernel and tended to decrease in the subsequent technological operations. The greatest reduction was observed during rinsing and storage. Although the amount of flavonoids in the maceration of seedless husks was 0.91 g Catechin/L, it increased by 1.01 g Catechin/L in alcoholic fermentation and 1.31 g Catechin/L in resting, and in further technological operations, i. e., in rinsing, 0.80 g Catechin/L and showed a reduction of up to 0.11 g Catechin/L in storage (Fig. 2).

The antioxidant index was 57.61 mg/l in pith and peel maceration, which showed a decrease in alcohol fermentation and rest, an increase in rinsing, and finally a decrease in storage. A similar situation was observed in the maceration of the shell without kernels (Fig. 3).

Unlike studies [11–13] that investigated the effects of maceration before fermentation and the use of various yeasts [8], sulphite [9] and carbon dioxide macerations [10], as well as the effect of maceration temperature and duration on the quality of wines, this study did not investigate the effect of grape solids on the quality of the future wine during the maceration process. It was found that the amount of phenolic compounds was higher during skin fermentation and lower in other processes. The lowest amount of phenolic compounds was observed after rinsing. As for the amount of flavonoids, on the contrary, its amount was low during fermentation in the peel, and increased during subsequent processes. The amount of anthocyanins increased after alcoholic fermentation compared to peel maceration and was observed to decrease again in subsequent processes. Although the antioxidant activity was relatively high during peel maceration, it decreased after alcohol fermentation and resting, but a trend towards increase was observed in the subsequent operations and it received a relatively high value after storage.

Phenolic compounds and antioxidant activity were studied during the fermentation, alcoholic fermentation, resting, clarification and storage processes in the mash using a pectolytic (3 g/hl) enzyme preparation. The amount of flavonoids was 1.30 g Catechin/L in kernel shell maceration, 1.87 Catechin/L during alcoholic fermentation, 1.86 Catechin/L in resting, 1.73 Catechin/L in rinsing, and 1.89 Catechin/L in storage. As it can be seen, an increase in the amount of flavonoids was noticed according to the technological stages. It was known that the amount of phenolic compounds, flavonoids and anthocyanins was selected because the amount of experimental samples with seeds was much less than those without seeds. The main point of interest is that in this series of experiments, the antioxidant capacity was slightly higher than the previous one and showed differences across operations (Tables 4, 5).

The amount of phenolic compounds during heat treatment of pulp with kernels was much higher than heat treatment of pulp without kernels. Antioxidant activity (DPPH EC50) was significantly lower in kernel operations than in the second one. Antioxidant activity in both cases significantly decreased in alcoholic fermentation, increased in resting; demonstrated by a decrease in leaching and retention (Tables 6, 7).

When studying the changes in the amount of anthocyanins during the stages of winemaking, it was found that the amount of anthocyanins in the fermentation with seed and skin maceration was 0.118 gMvd-3-0-glu/u, while in the fermentation without seeds this amount was 0.137 gMvd-3-0-glu/u. The amount of anthocyanins decreased significantly during the aging of the samples, and although the decrease continued during the clarification stage, it was accompanied by a kind of stabilization during storage (Fig. 4).

Phenolic acids – hal, protocatechin, chlorogenic, p-coumaric and ferulic acids and flavanol derivatives – catechin, (–)-epicatechin, (–)-epigallocatechin were detected in the wine samples taken at the end of the fermentation operations during the analysis by high-density liquid chromatography (HDLC). has been done. Phenolic acids and anthocyanins were the main compounds in the samples obtained during seedless fermentation, and catechin and its derivatives in seed fermentation (Fig. 5, 6).

Malvinidin-3-glucoside was found to be the main compound among monomeric anthocyanins in the Madrasah wine sample obtained by seedless fermentation, and in addition to this compound, delphinidin-3-glucoside, cyanidin-3-glucoside, peonidin-3-glucoside, petunidin-3-glucoside with monomeric glycosides. aglycones of cyanidin, peonidin, malvinidine were detected (Fig. 7).

Unlike the study [5], where the multiplicity of factors does not allow for a complete assessment of the issue, i. e., the maceration and fermentation process was carried out at different temperatures and using different yeasts, the effect of maceration time and yeasts on the physicochemical properties of wine samples was studied in this study. It was found that the amount of titra table acids was 6.09 g/dm^3 in samples macerated and naturally fermented for 48 hours, and 6.04 g/dm^3 in samples fermented with cultured yeasts. In samples macerated for 96 hours, this indicator increased slightly and was 6.18 g/dm^3 and 6.15 g/dm^3, respectively. In both cases, slightly lower acidity was noted in fermentation with cultured yeasts.In all wine samples, the amount of free SO_2 varied between 12.42–13.22 mg/dm^3, and the amount of total SO_2 varied between 17.17–18.14 mg/dm^3. The darkness of the samples fluctuated between 9.98–10.20 h %. The amount of volatile acids was 0.20–0.31 g/dm^3 within the norm (Table 8).

After maceration and fermentation, the color indicators of the wine samples were analyzed. After 48 hours of maceration, the value of L in the samples varied from 20.34 to 21.05. After 96 hours of maceration, a slight decrease in L value was observed, its value fluctuated between 18.48 and 18.90. Looking at the value of a, it was found that this indicator is much lower in 96-hour maceration than in 48-hour maceration. A similar situation was observed in b values. As it can be seen, the color values of the samples after fermentation were characterized by slightly lower values compared to the previous one. So, at this time, L values varied between 17.22–18.03, a values between 0.98–2.15 and b values between 1.24–1.82 (Tables 9, 10).

The amount of total phenolic compounds in the samples after maceration was 1104 gGAE/L, 1070 gGAE/L and 1630 gGAE/L, respectively. It was found that an increase in the total amount of phenolic compounds was observed after 96 hours of maceration compared to 48 hours of maceration. After fermentation, there was a significant decrease in the total amount of phenolic compounds. This can be attributed to the precipitation and

conversion of phenolic compounds during fermentation. The amount of monomeric anthocyanins varied between 65.42–86.01 mg mv-3-glu/L after maceration, while this indicator decreased slightly after fermentation and varied between 63.48–72.41 mg mv-3-glu/L (Table 11).

Among phenolic acids, quinic acid was distinguished by its higher amount. The amount of quinic acid in the samples after maceration fluctuated between 36.93–66.05 mg/l. At this time, the highest value was observed after 48 hours of maceration. After fermentation, there was a decrease in the amount of this ink in the samples. After quinic acid, it appears that halic acid and (+)-catechin have a superior position over other acids in terms of quantity. While the amount of halic acid was 4.36–8.23 mg/l in the samples after maceration, it showed an increase and fluctuated between 7.13–17.34 mg/l after fermentation. A similar situation was observed in the amount of (+)-catechin, i.e., its increase occurred in the samples after fermentation (Table 12).

Unlike previous studies [7] that investigated the effect of fermentation temperature and different strains of yeast on the quality of red wines, the evaluation of yeast strains in terms of temperature tolerance[4] and the effect of microwave treatment on indigenous yeasts [6], as well as the development of bacterial populations in winemaking using carbon dioxide maceration and the standard comb separation-crushing method, this study allowed for a comparative evaluation of natural and pure fermentation at different maceration times. It was found that after 48 hours of maceration, the highest amounts of aromatic compounds in wine samples fermented with cultured yeasts were glycerol (35.04 %), 1,2,3-propanetriol (32.15 %), and 2,3-butanediol (21.35 %).

In the TQ48 sample, glycerol (40.71 %), 1,2,3-propanetriol (26.30 %) and 2,3-butanediol (15.44 %) were ranked in order. If to take a look at the MMQ96 sample, it is ranked in descending order of glycerol (45.80 %), 2,3-butanediol (24.01 %) and 1-butanol, 3-methyl (8.6 %). In TQ96 samples, although the superiority of those compounds was maintained, differences in their quantity ratios were noticeable (Table 13).

During this research, it was found that the mechanical composition of the bunch in the autochthonous Madrasa grape variety changes depending on the number of bunches stored in the barrel. The role of the components that make up the bunch (skin, seeds, pulpy juice) in the winemaking process was experimentally determined, and the significant effect of maceration under different conditions, as well as the yeasts used in fermentation, on the composition of the future wine at different maceration times was experimentally confirmed.

The results of the study can be applied in the scientific fields of viticulture and winemaking. The obtained results can be used in scientific research works on winemaking, family farms and winemaking enterprises. The results of the study are on the verge of being applied in "Az-Granata" LLC (Azerbaijan). The expected economic efficiency for 1000 branches of natural Madrasa wine is 815.02 AZN (479 USD).

The study is suitable for red grape varieties, especially those with color substances located in the skin. In particular, there is a limitation for the application of seed-with-skin and seedless skin maceration in delicate white wines, as well as fruit and berry winemaking. The disadvantage of the study is the difficulty of separating the seed from the skin and the need for special equipment.

We consider the study of a number of issues envisaged in the research, including the change in antioxidant properties during the storage and maturation of wines, to be promising.

7. Conclusions

1. In technical grape varieties, the most important for the structure of the bunch is the amount of juice in %. This indicator varied between 83.85–86.03 % for options. The structural index (the ratio of the mass of juicy pulp to the mass of solid residue in the bunch) is important for technical varieties, the higher it is, the higher the juice yield in direct pressing of grapes. The structural index fluctuated between 5.2–6.2, and there was no significant difference between the variants. In the Madrasa grape variety, as the number of clusters stored in the barrel increased, a deterioration in the composition and quality of the wine produced was observed.

2. The amount of phenolic compounds was higher in the fermentation of the pulp with the seed (maceration with the peel) than without the seed. While there was no significant difference in the amount of total phenolic compounds during the stages of fermentation, rinsing and storage, it was characterized by the highest amount (1.87 gAE/L) during alcohol fermentation, and the lowest value (1.22 gAE/L) during the rest period.

3. The amount of anthocyanins in peel maceration with seeds was 0.118 gMvd-3-0-glu/u, this amount was 0.137 gMvd-3-0-glu/u in fermentation without seeds. Looking at the stages of winemaking, it is known that after alcohol fermentation, those indicators were 0.140 and 0.208 gMvd-3-0-glu/u, reaching the maximum, respectively. The amount of anthocyanins significantly decreased during resting samples, and although the decrease continued during the rinsing phase, it was accompanied by a kind of stabilization during storage.

4. The samples obtained from the Madrasa grape variety, macerated for 48 and 96 hours, were divided into two parts, one of them was fermented with natural (TQ) and the other with cultured yeasts (MMQ). The amount of total phenolic compounds and phenolic acids in TQ (1096 gGAE/L; 1236 gGAE/L) was lower than in MMQ (1112 gGAE/L; 1530 gGAE/L) samples, while in natural fermentation, on the contrary, the amount of aromatic compounds was higher than in samples fermented with cultured yeasts.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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Data availability

Data will be made available on reasonable request.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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