Madrasa grape variety, juice, pulp, wine material, auxiliary materials, technological methods and tools were taken as the object of research. Madrasa is an autochthonous grape variety belonging to the Nagorno-Karabakh region of Azerbaijan. The lack of full study of the quality resources of this variety, especially its color (red, pink and white) and lack of research in the direction of producing wines that differ in quality remains a problem.

The sugar-acid index and phenolic ripeness were determined in Madrasa grape variety, reflecting the optimum ripeness.

Active color and Colagel Clar were used in order to obtain natural wines with different colors. As the dose of the drug increases, the corresponding decrease in the amount of these substances is noticed. At the dose of 80 g/hl of the drug, both total and monomer anthocyanins were not matched and the sample became colorless.

While the wine sample that was not stored and matured (control) received 7.7 points, the wine sample stored for 6 months in internally burned barrels had 7.9 points, and during that time, the internal the sample of wine stored in an unburnt barrel was rated 8.5 points. A sample of wine stored in internal fired barrels for 12 months was evaluated with 8.6 points and a sample stored in non-internally fired barrels with 8.7 points. An apparatus-technological scheme for the production of wine, which differs from the autochthonous Madrasa grape variety in terms of color and quality, has been developed. The technological scheme allows the production of wine varieties that differ in terms of gin and maturation period, based on the existing flow line for the production of red wine

Keywords: red grapes, different colored wines, ripeness, active coal, Collagel Clar, white wines, pink wines, Madrasa grape, winemaking, phenolic acids

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IDENTIFYING OF THE WINE-MAKING POTENTIAL OF THE AUTOCHTHON MADRASA GRAPE VARIETY OF DIFFERENT COLORS AND QUALITY

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1. Introduction

In accordance with the state program on the development of winemaking in the Republic of Azerbaijan in 2018–2025", it is predicted that the area of vineyards in the country will be increased to 50 thousand hectares and grape production to 500 thousand tons in the near future. It is expected that 70 % of the grapes produced will be directed to wine production, thus increasing the volume of wine produced in the country to 3 million tons. Considering that the consumption of wine in the country is close to 1 million decaliters, it becomes clear that the additional wine produced will be directed to export [1].

To achieve the set goal, the selection of high-value grape varieties suitable for different wine types and local conditions has a special role. The variety of grapes, the region chosen according to sort and the compatibility of soil conditions, favorable climatic and weather conditions are the prerequisites for the production of quality wine.

A comparative analysis of Cabernet Sauvignon of French origin and Santgiovese of Italian origin, cultivated in the Tuscany region of Italy, showed that Cabernet Sauvignon loses its French brilliance, although it is obtained with a bright southern temperament. The local variety, Sangiovese, stands out in Tuscany for its superior hues. The sun, the wind and the soil itself help the sort to unlock its potential. In this regard, autochthonous grape varieties have an exceptional role. Autochthon is derived from the English word Autochthon, which means aboriginal or native. Such varieties are usually maximally adapted to the natural conditions of the country or region where they are distributed and produce wines of wonderful quality.

The advantage of autochthonous varieties is that they ideally reflect the terroir of the area where they were born.

In local conditions, it is very important to evaluate the quality characteristics of autochthonous grape varieties and the wines made according to the type of wine. At the same time, the purchase of different colored wines from such varieties is not sufficiently studied and it is important to study them.

In particular, the wine-producing potential of this variety in different colors and types is still not fully revealed. Apparently, there is a scientific problem in front of the field that requires a solution.

2. Literature review and problem statement

A more valuable feature of local grape varieties is their biological adaptation to local stressful environmental conditions. So, the subtropical warm humid climate limits the normal functioning of many popular varieties, they become infected with diseases, and their cultivation becomes economically unfavorable. To overcome these difficulties, wines from the vineyards in the Tuscany region (Italy) were tested, along with samples from 18 different geographical regions, to determine [2] how they differed from other Italian wines. This approach was used to protect the brand of wine produced in Tuscany and prevent counterfeiting. The paper [3] presents characterization of the organic, inorganic and isotopic structure of 3 red local wines (Cabernet Sauvignon, Malbec, Syrah) depending on the regional composition of soils in Argentina is given (Mendoza, San Juan and Córdoba). The purpose of this study was to develop reliability and chemical characteristics. The soil and wine were taken from three regions. The phenolic profile of wines was determined by high-density liquid chromatography. The use of the two studied matrices (wine and soil) showed that there was a consensus between them and it was determined that there was a sharp difference between the studied regions.

The work [4] proposed a simple method for determining the chromatic characteristics of wine is proposed. The measurement of the emission coefficient at 3 wavelengths was used.

As a result of research [5], it was found that wine grown in barrels under high oxidation conditions has a strong demand for oxygen. It has been shown that less time is spent on oxygen absorption, which leads to a significant increase in color intensity.

There are studies [6], where Cabernet Sauvignon was pre-seasoned and aged in new French oak for 15 months, then bottled for 3 months. Analysis of key compounds, including phenol and volatile components, showed differences between wines grown in old and new barrels.

In local grape varieties with a high level of adaptation, the risk of crop destruction due to adverse weather factors is low. This raises the level of profitability of vineyards consisting of local varieties, improves their economic indicators and normalizes the ecological situation in the regions where grapes are grown. One of such varieties is the Madrasa grape variety belonging to the mountainous Shirvan region [7].

Very ancient Aboriginal grape varieties spread to different regions and are found in both cultivated and crab forms. It should be noted that crab forms play a more valuable role as a genotype of the World plant gene pool, especially autochthonous grape varieties.

Phenol compounds in pink wines from two different southern Italy grape varieties were studied after 4 months of storage [8]. It has been shown that the amount of phenol compounds determines the color of pink wines and pink wine obtained by polymerization of flavonels in grape peel is the color of "onion peel".

Madrasa grape variety is one of the valuable local red varieties of Azerbaijan with universal characteristics. The fact that it can be used both fresh and for technical purposes has given this sort a special advantage. It is known that when used for technical purposes, quality juices and wines are produced from it. Natural wine with the brand name "Madrasa" is one of the well-known samples outside our country. In addition, "Shamakhi" kagor wine of the world famous dessert brand is made from Madrasa grape variety with local "Kurdamir technology". As can be seen, the madrasa grape variety has proven itself and is known as a suitable raw material for the preparation of wines of various types (natural, champagne material, dessert, etc.). However, it is too early to say that the high potential indicators inherent in the madrasa grape variety have been completely opened and used. In particular, the potential of this variety for producing wine in different colors remains not fully revealed. The production of pink and red wines from the Madrasa variety with the use of different technologies is known. However, it should be noted that there is not enough research on the production of white wines from it.

Present the study of the possibility of obtaining wines of different colors from autochthonous varieties in the world is considered a trend. Apparently, there is a scientific problem in front of the field that requires a solution.

The article [9] presents the results of the influence of storage time and conditions on the physico-chemical and organoleptic characteristics of pink wines made from the Madrasa grape variety. But unresolved issues remained related to the technology and hardware development of wine from Madrasa grape variety in three colors (white, pink and red).

During the analysis of literature data, it was established that some researchers have obtained important results related to the study of quality resources of different autochthonous varieties of grapes grown in different regions. This also applies to the definition of criteria that guarantee the authenticity of these wines. However, in these studies, the production of wines of three colors (especially white) from autochthonous red grape varieties was not sufficiently investigated.

3. The aim and objectives of the study

The aim of the study is to identify the potential of the autochthonous Madrasa grape variety to produce wines of different colors and quality.

To achieve the aim, the following objectives must be solved:

– to determine the optimal ripeness by determining the sugar-acid and phenolic of raw materials;

– to study the production of different colored wines from red Madrasa grape variety;

– to evaluate samples that differ in color and quality of wine by physico-chemical and organoleptic methods;

– to develop of wine apparatus-technological scheme, that differs from the autochthonous Madrasa grape variety in terms of color and quality.

4. Materials and methods of research

Grapes, juice, wine, technological methods and tools are taken as research objects. The main hypothesis of the

study is the acquisition of wine samples of three colors from the red Madrasa grape variety. In the research process, the preparation of white wines from the Madrasa grape variety was experimentally justified. The research ensures that the process can be carried out in a shorter time and in a simpler way by ensuring that three colors of wine can be obtained from one variety at the same time.

Preparation and research of white, pink and red wine samples from the Madrasa grape variety, including comparative evaluation of samples that differ in color, storage time, and the type of material in which they were stored and grown, are conducted.

In order to investigate the quality resources of the Madrasa grape variety, the optimal ripening time is determined based on its sugar-acid index, phenolic ripeness and the amount of anthocyanins. By applying different technologies ("red method", "white method" and using Active Color and Kolagel Clar), white, pink and red wines are made from the Madrasa grape variety. The physico-chemical and organoleptic indicators of prepared wine samples are studied without storage and in the process of storage and maturation. On the basis of the received studies, an apparatus-technological scheme is being developed that allows the production of wines of different color and quality from one variety. The apparatus-technological scheme is prepared by adding the following elements on the basis of the VPKS-10 A flow line, which ensures the purchase of red wines by extraction. These elements include a shaft comb crusher, a membrane press and a doser.

The technology and its hardware support for the simultaneous production of white, red and pink wines from one variety make the time spent on individual purchases of those wines significantly shorter, and the equipment and production space are used more efficiently.

As the object of study – grape, juice, wine material, wine samples differing in color, their physico-chemical and organoleptic properties, technological means were taken.

In the course of the study, generally accepted, new and modified analysis methods are used. Control over the ripeness of grapes and determination of ripeness is carried out according to the existing rules [10].

Preparation and research of white, pink and red wine samples from the Madrasa grape variety, including comparative evaluation of the sample according to their color, storage period, and the type of material they were stored and grown in.

Pink wine from the Madrasa grape variety is made by separating the skin from the clay in a gentle manner. Activeted charcoal samples called Color everget D100 and Color Sorb were used to prepare white wine Color Sorb Activeted carbon preparation is available in standard 20 kg bags with multi-layer waterproof paper, or in special bags of 5 or 1 kg. For the processing of wine, its working solution is first prepared. The working solution is prepared using water or mulled wine. To do this, the coal powder is well dusted and mixed into the liquid with the help of mechanical mixers. Mixing is carried out in a predetermined time period. The working solution is prepared at a concentration of 10–15 % (depending on the mass). After obtaining a homogeneous solution and the intended time has elapsed, the wine is separated from the coal by filtering through a filter. The period of joint storage of wine with color Sorb brand charcoal is 2.0–2.1 hours. The mixing of charcoal and wine is done at the usual temperature, with a cycle of 60 times per minute. Treatment with Kolagel CL is carried out in the sequence of increasing the dose. Among the complex organic substances are chlorophylls, which give a yellow color, along with anthocyanids, which give a red color. Constituents such as carotenoids and tannins may also be involved in color. Hunterlab (Model D-9000 Color Difference Meter) analyzer was used to measure the color of wine samples. In Hunter, a-value measures redness and greenery, 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.

The wine samples obtained from the Madrasa grape variety in 3 colors were stored and matured in Az Granata OJSC (in production conditions) in internal fired and unfired barrels for 6–12 months according to the following options (each with 3 replicates):

– primary wine material (control);

– 1) aged for 6 months in internal charred oak barrels (No. 1);

– 2) aged for 6 months in internal unfired oak barrels (No. 2);

– 3) aged for 12 months in internal charred oak barrels (No. 3);

– 4) aged for 12 months in internal unfired oak barrels (No. 4).

Average samples organized by variants were brought to the laboratory and analyzed by physico-chemical and organoleptic methods. The tasting was performed with a 10-point rating system.

The color of wine samples is determined by spectrophotometry. the absorbance values of the samples were read at 420, 520 and 620 nm wavelengths. The different color combinations for the wines were calculated using the following formulas:

$$\text{Color density}=A_{420}+A_{520}+A_{620};$$

$$\text{Color tone}=A_{420}/A_{520};$$

$$\text{Yellowness percentage}=A_{420}/(\text{color density});$$

$$\text{Redness in percent}=A_{520}/(\text{color density});$$

$$\text{Blueness in percent}=A_{620}/(\text{color density}).$$

Based on the research carried out, an apparatus-technological scheme for the preparation of wines from the same variety, differing in color(white, pink and red), is being developed.

5. Results of the study of the potential of the autochthon Madrasa grape variety

5. 1. Determination of ripeness in Madrasa grape variety

Observations on the ripeness of Madrasa grape variety continued from mid-August to the first 10 days of October. The results obtained are given in the table below (Table 1).

Phenol ripeness is based on observation on the dynamics of aggregation of anthocyanins (color substances). As ripening progresses, the vacuoles of the bark cell of the cherry soften, and the anthocyanins contained in them easily pass into the liquid phase, releasing them. The greater the amount

of anthocyanins released, the closer it turns out that the phenol ripeness of the grapes is. It can be concluded that harvesting should be carried out when the maximum amount of anthocyanins is recorded. But this is not the case. Optimum maturity occurs after the anthosians drop slightly below their peak state (when decreasing by 20–30 mg/l), which corresponds to about 8–10 days later. Such a decrease is associated with the beginning of the ripening and overtaking process. During this period, the solubility of high-quality tannins of the clay shell increases actively, and at the same time, the extractivity of coarse tannins of the seed decreases. It is possible to state what has been mentioned schematically as follows (Fig. 1).

Table 1

Determination of ripening dynamics in Madrasa grape variety

Dates of observation	Sugar, g/dm^3	Acidity, g/dm^3	Sugar/Acidity
August 18	72	17.6	4.0
August 24	100	13.1	7.6
August 31	134	9.02	14.0
September 7	166	6.86	24.0
September 14	172	5.68	30.0
September 21	183	5.22	35.0
September 28	192	4.90	39.0
October 5	192	5.10	37.0

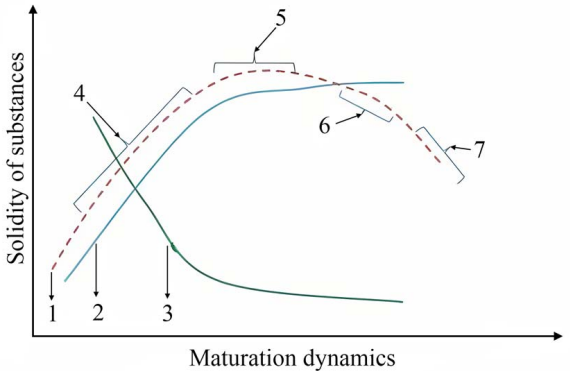

Fig. 1. Ripening dynamics in Madrasa grape variety and its dependence on anthocyanins concentration: 1— anthocyanins; 2 — sugar; 3 — acidity; 4 — immature; 5 — primary maturity; 6 — full maturity; 7 — matured and passed

The situation in which anthocyanin – 1 increases is also observed with the increase of sugar – 2, and this situation corresponds to the unripe state of grapes – 4. The decrease from the peak state of anthocyanins reflects a slight stabilization of sugars – 2 and the decrease of acids – 3 reflects the state of initial ripeness – 5. A significant reduction of anthocyanins from their peak state and a relatively stable state of sugar and acidity is consistent with full ripeness – 6. The complete decline of anthocyanins reflects the overripe – 7 state.

5. 2. Study of the production of different colored wines from red grapes

During the studies conducted, the different doses used of the Collagel Clear preparation to remove the color substances were comparatively analyzed. It was found that the total amount of phenol compounds in the control sample (without the addition of the drug) was 540 mg/dm^3, total anthocyanins 130 mg/dm^3 and monomer anthocyanins 75 mg/dm^3. The experiment was carried out on 5 options with an increase in the dose of the drug. At the lowest dose of the drug, i. e. 20 g/hl total phenol compounds decreased to 470, total anthocyanins to 115, monomer anthocyanins to 70 mg/dm^3. As the dose of the drug increased, the same decrease was noticeable with a larger amount. The amount of both total and monomer anthocyanins in a dose of 80 g/hl of the drug was not observed.

Hunterlab (Model D-9000 Color Difference Meter) was used to measure the color of red wine materials processed with active coal and Collagel CL. The results of the analysis are given below (Table 2).

Table 2

Effect of Active Color and Collagen Clear on the color of Madrasa wine samples

Color indicators	By years					
	2021		2022		2023	
	Control	Experience	Control	Experience	Control	Experience
L	7.04	22.3	5.18	16.9	8.01	18.50
A	6.21	–7.2	7.61	0.09	5.46	–3.40
B	1.02	8.16	1.01	7.31	0.09	9.36

Analysis of color measurements for 2021–2023 in the control (I) and experimental (II) variants shows that processing with active color has a fundamental effect on the color of wine materials. Processing of Madrasa wine sample with active color caused fundamental changes in color and resulted in loss of color.

5. 3. Physico-chemical and organoleptic evaluation of samples differing in color and quality of wine

The composition of wine samples made from Madrasa grapes using various processing methods was studied (Fig. 2).

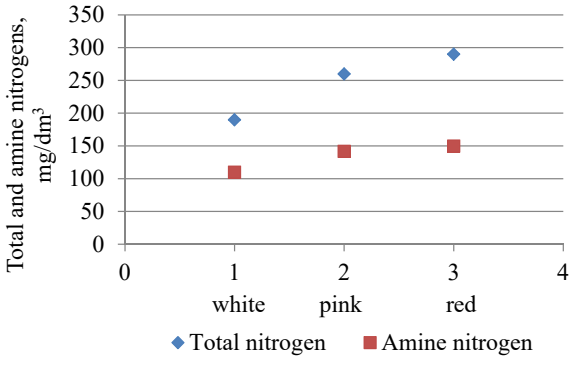

Fig. 2. Content of nitrogenous substances in white, pink and red wine samples made from Madrasa grape variety

The amount of phenolic acids in the investigated wine samples was determined (Table 3).

10 phenolic acids were detected in Madrasa wine samples. Among them, 2-hydroxycinnamic acid, 4-hydroxybenzene acid, and p-coumaric acid were the ones that showed an increase during the storage and growing period. A greater decrease was observed in the amount of epicatechin, kanferol and catechin.

Determination of color indicators in wine samples was performed in unstored wine samples (control), in samples stored and grown for 6 months and 12 months (Table 4).

Table 3

Amount of phenolic acids in Madrasa wine samples

Phenolic acids, mg/dm³	No. 0	Cultivation			
		No. 1	No. 2	No. 3	No. 4
Epigallocatechin	18.25	17.07	14.46	11.72	7.83
Epicatechin	97.09	18.61	16.34	16.44	13.61
Kanferol	24.42	16.51	19.44	2.05	1.34
Catechin	4.46	1.21	1.01	0.19	0.09
Caffeic acid	0.72	1.46	1.79	0.61	0.65
p-coumaric acid	0.04	1.05	2.34	0.15	0.53
Transferulic acid	1.21	1.42	2.24	0.02	0.01
2-hydroxycinnamic acid	1.18	1.07	1.10	2.21	2.20
4-hydroxybenzoic acid	0.0005	0.02	0.01	0.03	0.02
Dihydroxybenzaldehyde	–	3.01	2.63	1.15	1.15

Table 4

Determination of color indicators in Madrasa wine samples

Content indicators	No. 0	Determination			
		No. 1	No. 2	No. 3	No. 4
Color density	2.62	2.50	2.81	10.24	8.45
Color tone	0.96	0.92	0.91	1.02	0.84
Yellowness, %	0.34	0.34	0.36	0.42	0.40
Redness, %	0.35	0.36	0.36	0.39	0.45
Blueness, %	0.31	0.30	0.27	0.20	0.16

Table 5

Organoleptic evaluation of white wine samples from Madrasa grape variety

Practice options	Scoring elements, score					
	Transparency (0.1–0.5)	Colour (0.0–0.5)	Bouquet (1.0–3.0)	Taste (1.0–5.0)	Type (0.2–1.0)	Total score (up to 10 points)
Control	0.49	0.43	2.1	4.0	0.7	7.7
Test 1	0.48	0.43	2.1	4.0	0.8	7.9
Test 2	0.49	0.48	2.3	4.4	0.8	8.5
Test 3	0.46	0.48	2.4	4.5	0.8	8.6
Test 4	0.47	0.47	2.5	4.5	0.8	8.7

Table 6

Organoleptic evaluation of pink wine samples from Madrasa grape variety

Practice options	Scoring elements, score					
	Transparency (0.1–0.5)	Colour (0.0–0.5)	Bouquet (1.0–3.0)	Taste (1.0–5.0)	Type (0.2–1.0)	Total score (up to 10 points)
Control	0.48	0.42	2.2	3.8	0.7	7.6
Test 1	0.48	0.42	2.2	4.0	0.7	7.8
Test 2	0.49	0.43	2.3	4.4	0.8	8.4
Test 3	0.48	0.45	2.4	4.4	0.8	8.5
Test 4	0.47	0.46	2.5	4.4	0.8	8.6

Table 7

The organoleptic evaluation of red wine samples produced from Madrasa grape variety

Practice options	Scoring elements, score					
	Transparency (0.1–0.5)	Colour (0.0–0.5)	Bouquet (1.0–3.0)	Taste (1.0–5.0)	Type (0.2–1.0)	Total score (up to 10 points)
Control	0.47	0.43	2.1	3.9	0.7	7.5
Test 1	0.48	0.43	2.2	3.9	0.7	7.7
Test 2	0.48	0.44	2.3	4.1	0.8	8.1
Test 3	0.48	0.43	2.4	4.3	0.8	8.4
Test 4	0.48	0.44	2.5	4.4	0.8	8.62

The color of red wines changes regularly during production and maturation due to polymerization and degradation reactions between phenolic compounds. Color combinations undergo rapid changes during the aging of wine samples in oak barrels. Barrel-aged wines have higher color density and color stability than controls. Color change in barrel-aged red wines can be attributed to the interaction between anthocyanin and flavanols in an aldehydic environment, the reaction between malvidin 3-glycosides and oak ellagitannins, and the reactions between anthocyanin-pyruvic acid compounds and vanillin-flavanol compounds. Due to the porous structure of oak wood, air oxygen passing through it is one of the main factors in the formation of wine color. During the introduction of oxygen into the wine, a change occurred in the color combinations of red wines, a decrease in the redness (A_{520}), yellowness (A_{420}) and in the color density of the ripening wine. Wines grown in oak were noted to have higher color density and redness compared to the control. The increase in color density and color stability of wines during maturation is due to the polymerization and other reactions of anthocyanins.

The results of organoleptic evaluation of samples of white, pink and red wine made from Madrasa grape variety are given below (Tables 5–7).

It is noticeable that the samples of pink wine made from the Madrasa grape variety were rated higher by 0.2–1.0 points compared to the control. Among the experimental variants, the sample stored in internal fired barrels for 6 months was the lowest rated and 0.2 points higher than the control, while the sample stored in non-internally fired barrels for 12 months was the highest rated.

Samples of red wine made from Madrasa grape variety received grades between 7.5–8.6 points.

Comparing the results of the organoleptic assessment of Madrasa wine samples, which differ in color, with each other, it can be seen that white wine samples differed from others in that they received slightly higher marks. This testifies to the possibility of obtaining elegant and sort-specific fresh white wines from the Madrasa variety.

5. 4. Development of apparatus-technological scheme for the production of wine that differs from the autochthonous Madras grape variety in color and quality

On the basis of the researches, the technological scheme of preparation of various types of wines from Madrasa grape variety has been developed (Fig. 3). According to the same scheme, the grapes brought by the container-1 are unloaded into the receiving-feeding hopper – 2, from which the grapes are directed to different lines depending on the type of wine. If red wine is to be obtained from the Madrasa variety, then the grapes are directed by a crusher comber – 3, which works by centrifugal force. Here, the grape is crushed and the comb is separated, and the obtained crushing pump – 4 is supplied to the extractor-vinifier – 6 by sulfitation in the sulfitizer –5. Here, after the juice has fermented slightly, a "cap" is formed on the surface of the juice. The formed" cap " enters the Squeezer-8 from the top of the extractor. And from the lower part of the extractor, a slightly fermented juice, separated by its own stream, enters the collector – 7. Slightly fermented juice from both here and from the squeezer is directed to the pressure reservoir –10, or to the

collecting reservoir – 12 (for natural wines with sugar residue). At the same time, the juice is circulated by spraying it together or separately on the extractor-vinifier –6 caps from the top side.

On the basis of the conducted researches, the apparatus-technological scheme of making different types of wines from the Madrasa grape variety was developed (Fig. 3). According to that scheme, the grapes delivered by container-1 are unloaded into the receiving-feeding bunker –2, from where the grapes are directed to different lines depending on the type of wine. If red wine of the Madrasa variety is to be bought, then the grapes are sent to the centrifugal press – 3. Here, the grapes are crushed and separated from the comb, and the received crushing pump – 4 is sulfitized in the sulfitizer – 5 and sent to the extractor-vinifier – 6. Here, after the juice ferments a little, a "cap" is formed on the surface of the juice. The formed "cap" enters the compressor –8 from the top of the extractor. From the lower part of the extractor, slightly fermented juice separated by its flow enters the collector –7. The slightly fermented juice from both here and the press is directed to the pressure reservoir –10, or to the collecting reservoir –12 (for natural wines with residual sugar). At the same time, the same juice is circulated together or separately to the extractor-vinifier – 6 by spraying it on the cap from the top. The slightly fermented juice from the pressure tank – 10 is fed to the fermentation reservoir – 11 for final fermentation. Here, the fully fermented sour wine material is introduced into the collecting reservoir –12 by passing through a 3-way tap. From here, the red wine material can be filtered –21 for bottling or stored and matured in oak barrels-22.

From the pressure reservoir – 10 slightly fermented juice is fed to the fermenting battery-11 to be fermented to the end. Here, the sour wine material, fermented to the end, is introduced into the collecting reservoir –3 by passing through a 12-way tap. From here, red wine material can be supplied to the tank-21 for refilling or mugging.

If it is necessary to make white or pink natural wines from Madrasa grape variety, the grapes are fed from the receiving-feeding hopper – 2 directly to the comb shaft crusher –13. Here, in a gentle mode from the vine, the comb is first separated, and the mash is transferred to the membrane press – 15 with a screw monopump – 16 located under it. Under oxygen-free conditions in a membrane press, the juice is separated by an equal level of pressure, which falls into the crush. The separated juice is pumped into the perlite vacuum filter by passing through the heat exchanger – 17 with a screw pump –16 located under the membrane press. Here, the purified colorless juice is fed into the tank – 19 collector with a jacketed and fermented according to the type of wine obtained in a controlled manner. If it is necessary to buy pink wine, the material here is mugged with 20 red wine materials in the jacketed reservoir. If grown wine is to be made, samples of either white or red wine are to be stored in oak barrels – 22, while non-grown wines are directed directly to refilling.

If Madrasa needs to make white or pink natural wines from grape varieties, the grapes are fed directly from the receiving-feeding hopper –2 to the comb-shaft crusher – 13. Here, the comb is first separated from the grapes in soft mode, and the pulp is transferred to the membrane press –15 with the screw monopump – 14 located below it. In a membrane press, the juice is separated by a uniform pressure applied to the crush under oxygen-free conditions. The separated juice is directed to fermentation by passing through the heat exchanger –17 with a screw pump – 16 located under the membrane press. If rosé wine is to be obtained, fermentation is carried out in a jacketed collector tank – 18. Thus, fermentation is carried out here in a controlled manner according to the type of wine. If it is necessary to buy white wine, the tap to the jacketed collection reservoir – 18 is closed and the material is fed to the jacketed-mixer reservoir – 19. On it, experimentally determined amounts of active color and Kolagel Clar are dosed from the doser – 20 and mixed using a mixer until a homogeneous mass is obtained. The colorless juice obtained here is fermented according to the type of white wine. After the completion of the mentioned processes, the first sample of pink wine is taken from the jacketed collecting tank-18 and passed through the three-way tap to the filter –21. If white wine is to be produced, the flow of pink wine is stopped through that crab and the white wine is transferred from the jacketed-mixer reservoir – 19 to the filter – 21. Wine samples of different colors (red, pink, white) taken sequentially from the filter by means of a three-way tap are directed to be stored in oak barrels –22 if matured wine is to be made, and directly to bottling if non-matured wines are made.

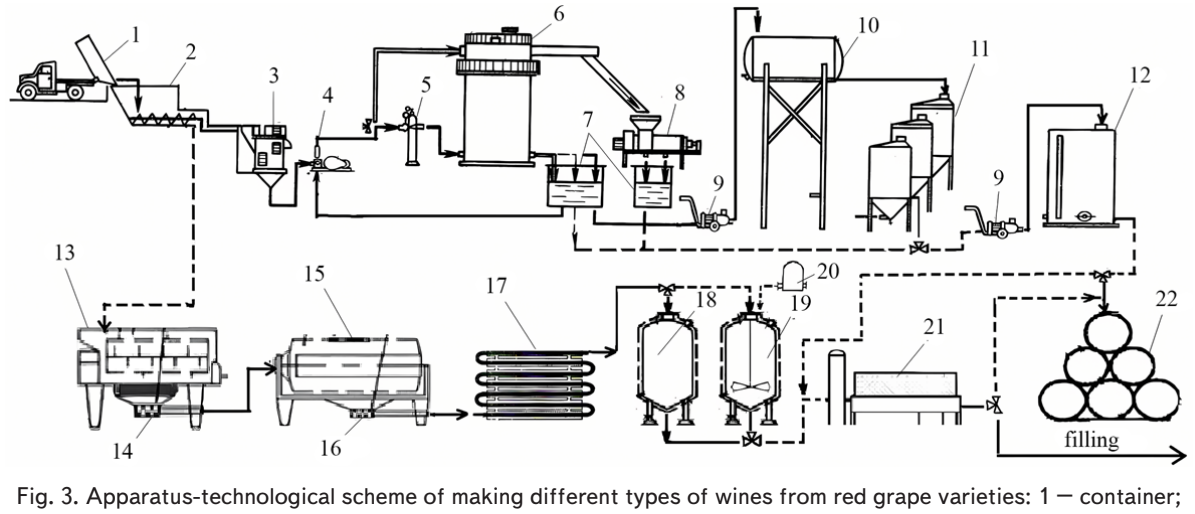

Fig. 3. Apparatus-technological scheme of making different types of wines from red grape varieties: 1 — container; 2 — receiving-feeding hopper; 3 — crushing comber; 4 — pressure pump; 5 — sulphitizer; 6 — extractor-vinifier; 7 — juice collector; 8 — pressing; 9 — juice-wine pump; 10 — pressure reservoir; 11 — fermentation reservoirs; 12 — collecting reservoir; 13 — comb-shaft crusher; 14 — screw monopump; 15 — membrane press; 16 — screw pump; 17 — heat exchanger; 18 — jacketed collector reservoir; 19 — jacketed mixer tank; 20 — doser; 21 — filter; 22 — oak barrels

The apparatus-technological scheme was created on the basis of the VPKS-10 A flow line intended for the extraction of red wines. In contrast to the traditional line, in the study, a shaft combing crusher, a membrane press and a doser were used. This improvement of the line has made it possible to produce wines with three colors and different qualities (uncultivated and cultivated) at the same time.

The proposed technology and its hardware ensure simultaneous acquisition of wines of three colors (white, red and pink) from the red grape variety. It provides economic benefits by significantly shortening the time spent on purchasing white, pink and red wines individually, and by creating a basis for more efficient use of equipment and production space.

6. Discussion of the results of the study of the quality resources of the autochthonous Madrasa grape variety

The optimal parameters of technical ripeness of the Madrasa grape variety have been determined, and wines of different color, composition and quality have been prepared. A comparative analysis of the physico-chemical (composition indicators and organoleptic properties) of wines differing in color is given. At the same time, wine samples were studied by keeping and growing in internal burned and unburned oak barrels for 6 and 12 months.

As a result of observations and analyzes of grape ripening between August 18 and October 5, it was found that the amount of sugar in the juice corresponding to technical ripeness is 192 g/dm^3, the titratable acids are 4.90 g/dm^3, and the sugar-acid index is equal to 39 at this time (Table 1). Phenolic ripeness was determined by organoleptic (rind, pith and stem ripeness) and anthocyanins determination. This coincides with the state of anthocyanins falling from their peak state by 20–30 mg/dm^3, i. e. 10 days later (Fig. 1).

Technological methods were used that take into account that color substances are mainly located in the skin part of Madrasa grapes. Different doses (20, 40, 60, 80 and 100 g/hl) of Colagel Clar and active color preparation were added to the juice obtained by gently separating the pulp from the peel.

It was found that the color was not fundamentally affected at low doses of the drug, although 150 mg/dm^3 of total phenolic compounds were found at the dose of 80 g/hl, the amount of total and monomeric anthocyanins was not found, and the sample became completely colorless (Table 2).

As it is known, the color values (*L*, *a* and *b*) changed in the samples treated with active color and Colagel C compared to the control. The value of L in the 2021 sample was 7.04 in the control sample and 22.3 in the experimental sample. A similar situation was observed in 2022 and 2023. In 2021, the value of a significantly decreased compared to the control (6.21) in the experimental version and became -7.2, and this regularity continued in other years as well. An increase in b value over the years (from 1.02 to 8.16 in 2021; from 1.01 to 7.31 in 2022; from 0.09 to 9.36) was noticed (Table 2).

While the amount of total nitrogen in the white wine sample made from the Madrasa grape variety was 290 mg/dm^3 and amino nitrogen was 150 mg/dm^3, it was 260 and 142 mg/dm^3 in the pink wine sample and 190 and 110 mg/dm^3 in the white wine sample (Fig. 2).

When the red wine samples were stored and grown in oak containers, a decrease in the amount of phenolic acids was observed compared to the control. While the amount of epicatechin, one of the more reduced acids, was 97.09 mg/dm^3 in the control sample, it decreased during storage and was 13.61 mg/dm^3 after one year of storage (Table 3).

The color density of the non-preserved (control) samples kept for 6 months and 12 months was 2.62 in the control version, this indicator was weak in the samples kept for 6 months, and there was a substantial increase in the samples kept for 12 months. In option 3, this indicator was 10.24, in option 4 it was 8.45 (Table 4).

Redness and yellowness of cultivated wines increased and blueness decreased (Table 4).

During the cultivation of wine samples differing in color, white wine samples were evaluated 0.2–1.0 points higher than the control (7.7 points), in this case, the 4th option, i. e., the sample stored for 12 months, was awarded with the highest value (Table 5).

A similar situation with white wine samples was observed during storage and cultivation of pink (Table 6) and red (Table 7) wine samples. During the comparative analysis of the wine samples, which differ in color, it was found that the 4th variant was awarded the highest price in the samples of white, pink and red wines obtained from the Madrasa grape variety.

In the white wine sample, that option was evaluated at 8.70 points, the pink wine sample at 8.60 points, and the red wine sample at 8.62 points. Although the Madrasa grape variety produces quality wines in all three colors, among them the white wine samples have taken a higher position due to the elegance and freshness characteristic of the variety.

A technological scheme has been developed that allows Madrasa to buy wines of different color and quality at the same time. This line was developed on the basis of the VPKS-10A flow line and successfully passed the production test at the AZ-Granata juice and wine processing plant (Fig. 3).

The use of a mine comb crusher with, membrane press and a dispenser in the technological scheme is economically beneficial, since wines of three colors are simultaneously produced – white, red and pink. This also gives the advantage of efficient use of equipment, production space and reduces time.

Research is limited to all grape varieties, especially Muscat.

The disadvantage of the study is that it was conducted only on grape varieties whose coloring substances are contained in the skin.

In the future, prospectively conduct research on grape varieties, which coloring substances are found in the berry pulp.

7. Conclusions

1. Madrasa grape variety ripening was studied. It was found that optimum maturity coincides with the period when anthocyanins fell slightly from their peak state (decreasing by 20–30 mg/l). During this period, the solubility of high-quality tannins in the clay shell increases, and at the same time, the extractivity of coarse tannins of the seed decreases.

2. Different technologies, including active coal and Kolagel Clar preparations, widely used in winemaking, were used to obtain wine samples with different colors from Madrasa grape variety. At the lowest dose of the drug Kolagel Clar (i. e. 20 g/hl), total phenol compounds decreased to 470, total anthocyanins to 115, monomer anthocyanins to 70 mg/dm^3. As the dose of the drug increased, the decrease in the amount

of the mentioned substances became more noticeable, and at a dose of 80 g/hl of the drug, the amount of both total and monomer anthocyanins was not coincided and discoloration was observed in the sample.

3. In wine samples of different colors from the same variety, it was noticed that total and amino nitrogen were lower in pink and white wines than in red wines. An increase in the amount of 2-hydroxycinnamic, 4-hydroxybenzene and p-coumaric acids, and a greater decrease in the amount of epicatechin, kanferol and catechin was observed in Madrasa wine samples during cultivation. During the comparative analysis of wine samples by the organoleptic method, some samples of white and pink wines were superior to red ones, and the samples of white wines were selected for their delicate and typical freshness.

4. The apparatus-technological scheme of preparation of various types of wines from Madrasa grape variety was developed. The difference of the proposed apparatus-technological scheme from the traditional line intended for the production of red wines is the use of a crusher with a comb shaft, a membrane press and a dispenser, which allows the production of fine wines.

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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