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STUDY OF THE INFLUENCE OF DIFFERENT TECHNOLOGICAL METHODS ON THE COMPOSITION AND QUALITY OF MARSALA COUPAGE COMPONENTS

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Abstract. The grape variety and production technology used to make Marsala determine the quality and composition of the coupage components. Choosing the grape variety suitable for the region as well as the most advanced technological schemes for producing coupage components with a sufficient level of dry matter are still unsolved issues. The purpose of the work was to study the influence of various technological methods on the composition and quality of the components of the coupage used in the preparation of Marsala-type wines. Wine samples were prepared by the following methods: the white method (control), storage in the mash, fermentation in the mash and heating in the mash, as well as by the kakhetian method and then they were alcoholized. Compared to the control, the amount of sugar-free extract increased by 1.5 g/dm3 during 12 hours of storage in the mash, by 2.9 g/dm3 during 24 hours of storage in the mash, and by 9.3 g/dm3 during fermentation in the mash. Coupage components prepared by thermovinification and Kakhetian methods differ in their richer extractability. There was nearly a 1.0-1.5-fold increase in the amount of sugar-free extracts in the experimental variants compared to the control. This indicator reached its peak in the sample made by the Kakhetian method. We can see an increase in the amounts of polysaccharides, pectin substances, saturated ethers, phenolic compounds and nitrogenous substances. Due to cloudiness, different results were obtained. In other words, the clearest sample was observed in the white method (control), and there was an increase in cloudiness after contact with the mash. According to the organoleptic assessment, the indicators for the experimental samples were higher by 0.05-0.20 points compared to the control. It was found that when alcoholized juices were prepared, the amount of sugar-free extract increased with the increase of storage time in the mash and reached its peak in the variant of "48 hours of storage" in the mash.

Corresponding dynamics can be observed in the amount of total and amino nitrogen.

Keywords: grapes, wine, marsala, alcoholized juice, wine material, alcohol

Introduction. Formulation of the problem

The homeland of Marsala fortified wine is the cities of Marsala, Trapani, and Casrella-Mare, located in the western part of the Italian island of Sicily. It differs from other fortified wines since it contains more melanoidins and sugar-free extract. However, a greater concentration of aldehydes is needed for these wines, including formaldehyde, furfural, oxymethylfurfural, vinegar, isovalerian aldehyde, and others.

Marsala is known to be a coupage wine. The coupage components must have the required compositional indicators in order to guarantee the aforementioned content. The type of grape utilized for this purpose should accumulate a lot of sugar and dry matter but have a low concentration of titratable acids. As it is known, the products of the reaction of glycerol, nitrogenous compounds, phenolic compounds, and melanoid formation play a role in the formation of the extract. Therefore, the maximum transfer of individual chemical components (nitrogenous compounds, phenolic compounds and other extract substances) from the solid parts of the berry to the juice should be ensured. Besides, the wine material should be enriched with carbonylamine reaction products. Thus, the composition and quality of the components of the coupage used for Marsala depends on the grape variety and the production technology. Therefore, it is important to choose the correct grape variety suitable for local conditions, as well as to develop an advanced technological scheme for preparing coupage components with a sufficient amount of dry matter.

Analysis of recent research and publications

Marsala is a fortified authentic wine reminiscent of sherry, port, and madeira-type wines. The distinguishing feature of this wine is the presence of a specific resin tone in its aroma. Along with its soft taste, the resin tone in the aroma is in good harmony with the tones of roasted walnut and rye husk [1].

The study aimed to determine the concentration of carbohydrates, polyphenols, and metals in different types of Marsala wines and to perform statistical classification through stepwise discriminant analysis. The obtained data prove that the different types of Marsala are correctly classified according to their phenolic and carbohydrate content. The overall statistical model showed that p-tirozol, caffeic acid, procyanidin B1, catechin, quercetin, kaempferol, lactose, rhamnose, zinc, copper, and lead vary with the highest discriminant power [2].

The aim of this study was to evaluate the effect of natural winemaking on the microbial and chemical composition of Marsala-based wine. For this, large-scale winemaking processes were controlled from the harvest to the final product in the Grillo grape variety. The change of yeasts and lactic acid bacteria was studied during the process. Besides, it was recorded how the alcohol and other constituent indicators, including volatile acids, pH, and quality composition of acids changed [3].

Twenty-nine Marsala varieties of different categories presented in the market were sorted according to grape variety, production technology, and cultivation. This study focused on the rapid and simple method of characterizing different categories using infrared spectroscopy. The proposed method is very attractive, it is distinguished by its simplicity and speed, and it does not require pre-treatment of the sample. In addition, it is environmentally safe and does not require organic solvents. This method allows checking for the correspondence of the Marsala wines to the indications shown on the label [4].

This research was focused on the investigation of the volatile component composition of Marsala wine. 2 DD-QX complex analysis was performed using solid-phase microextraction of 4 types of samples of different maturity and more than 500 peaks were detected. In 4 types of samples, 128 compounds (mainly complex esters, alcohols, ketones, and aldehydes) were detected. The data obtained indicate that Marsala wine has a rich content of volatile components [5].

In recent years, attention has been paid to the potential carcinogenic effect of 5-hydroxymethylfurfural on human health. This combination is taken as a sign of adulteration of honey and thermal processing of sugary food products. During the study, the average amount of 5-hydroxymethylfurfural was determined in different products. 5-hydroxymethylfurfural was observed to serve as a marker for using specific compounds in food preparation [6].

The researchers analyzed the ecology of the associated yeasts in the juice during self-fermentation of the Grillo grape variety harvested from 10 vineyards and 14 species belonging to 10 genera were recognized [7].

The characteristics and therapeutic effects of Marsala, Madera, Port wine, and Sherry wines, which are very popular in the world, are presented. It covers the traditional processes of winemaking, including microbiology and autochthonous yeasts, as well as normative aspects of the main fortified wines of Italy, Portugal, and Spain. The review concludes with an analysis of the various volatile and odorous compounds detected in wines fortified by oxidative maturation [8].

Using high-performance liquid chromatography, certain pentoses, hexoses, and disaccharides in Sicilian wines with controlled designation of origin were analyzed. Glucose and fructose were more prevalent in all wines. Only Marsala wine had residual levels of xylose, rhamnose, and lactose, while all Sicilian wines included maltose [9].

The climatic conditions of some regions of Azerbaijan are somewhat similar to the Sicilian region. Therefore, we believe that studying the production technology of Marsala-type wines under these conditions will not cause serious problems. This is proven by the fact that some of the fortified and dessert wines produced here have become brands. It is important to consider different options for choosing the optimal technological method in wine production. The technological schemes of the production of this type of wine are quite complex, including the preparation of the coupage components - unprocessed alcoholized sour wine material, alcoholized juice (mistelle); alcoholized and heat-treated vacuum juice [10].

The aim of this study is to determine the concentrations of carbohydrates, polyphenols and heavy metals in different types of Marsala wines and to achieve statistical classifications by canonical discriminant analysis (CDA). The results show that different types of Marsala are correctly classified according to their phenolic and carbohydrate content. Canonical discriminant analysis performed using heavy metals as independent variables showed that Superiore Ambra Secco and Vergine Marsalas were not subjected to different treatment. However, a good correlation was obtained between Fine Oro Dolce, Superiore Riserva and Fine Ambra Secco wines. Finally, the overall statistical model showed that the variables with the highest discriminant power were: tyrosol, caffeic acid, procyanidin B1, catechin, quercetin, kaempferol, lactose, rhamnose, zinc, copper, and lead[11]. It has been noted that Marsala wine is a magnificent synthesis of grapes and soil, unique due to its geographical and climatic characteristics. This chapter first discusses Marsala wine. It is noted that in

Trapani, grapes are grown on chalky and clayey soils and are constantly exposed to the influence of sea winds. White grape varieties predominate here. The next chapter reflects the process of making Marsala wine and wine production[12]. Marsala is the oldest fortified Sicilian wine, highly valued for its organoleptic qualities and production process. The aim of this study is to investigate the strengths, weaknesses, opportunities and treatment options of Marsala Vergine DOC wine to increase its market share. Focus group and factor analysis were conducted. The results highlighted the key factors that producers should focus on in order to reposition the wine in the market and respond to the preferences of different target consumers. Based on the results, integrated strategies can be developed with stakeholders[13].

A comparative assessment of some varieties cultivated in local conditions, including red varieties, was carried out. During the ripening of the studied grape varieties, the sugar content varied between 197-265 g/dm³, titratable acids between 4.5-7.7 g/dm³, and active acidity between 3.08-3.61. The mass concentration of sugar in the Khindogni grape variety was on average 197 g/dm³. The varieties were in increasing order of mass concentration of sugar: Madrasa 222 g/dm³, Cabernet-Sauvignon 226 g/dm³, Merlot 240 g/dm³, and Shirvanshahi 265 g/dm³. One of the important indicators determining the quality of the raw material is known to be the sugar-acid potential, in other words, the glucoacidometric index (GII). A comparison of their quantities showed that the amount of these compounds in the Madrasa grape variety was higher than in the other two grape varieties[14]. The object of the study is juice and wine samples obtained from the autochthonous Bayanshira grape variety. A number of studies have been conducted on this variety, but the dynamics of ripening of the berries and the mechanical composition of the bunch, the effect of applied technological methods on juice and wine indices have not been sufficiently studied. During the processing and storage of grape juice processed by white and other methods, it was determined that the physicochemical composition of hot pasteurized samples is more sensitive to changes compared to the control, while samples treated with ultraviolet rays retained their natural color and composition almost unchanged. The flow of nitrogenous substances into the wine increased from 30 to 90 days during their storage on yeast sediments[15]. The aim of the study was to investigate the effect of the maceration regime of the pulp on the amount of phenolic compounds and color indicators in autochthonous Madrasa wine samples. Maceration was carried out for 96 and 144 hours at low temperature (30ºC), room temperature (20ºC) and in the cellar (10 C). The highest content of phenolic compounds was observed during maceration for 144 hours at room temperature (20ºC) and 96 hours in the cellar (10ºC)[16]. The effect of ripening conditions on the mechanical, physicochemical properties of rose hips, as well as processing methods, especially hot processing, on the quality of the product was determined. It was found that during the initial hot processing of the raw materials, an increase in total phenolic compounds was observed, and a decrease in the amount of ascorbic acid occurred[17]. A total of 35 bound aromatic compounds were detected in juice samples prepared from the White Muscat grape variety, including 4 alcohols, 3 six-carbon compounds, 13 terpenes, 7 volatile acids, 4 volatile phenols, and 4 norisoprenoids. A total of 60 volatile compounds were detected in wine samples, including 17 alcohols, 15 esters, 13 acids, 5 aldehydes and ketones, 1 terpene, 5 volatile phenols, 4 lactones, and 1 aldehyde. This is higher than the amount of the same compounds in juice and is due to the new formation processes that occur during alcoholic fermentation[18].

The effect of various substances on the composition and quality of wine was studied. Only imazalil residue was 0.35 μg/dm3, when activated charcoal was used at a dose of 300 mg/dm3, and no other pesticides were found. When the next doses of activated charcoal (450 and 600 mg/dm3) were used, pesticide residues were completely eliminated. Thus, a dose of 450 mg/dm3 of activated charcoal was sufficient to completely remove pesticide residues from wine samples. A more significant dose of bentonite was 600 mg/dm3[19]. This study used residues from grape processing. The application of extracts prepared using them improved the quality of low-extract wines. It was found that the residues can also enrich the wines and other products to which they are added with dietary fiber[20]. The large-scale vinification process of the “Grillo” grape variety was monitored from harvest to the final product. At this time, the variable amount of yeasts and lactic acid bacteria in the microflora was determined. At the end of fermentation, the physicochemical composition indicators were determined and it was found that the pH value did not change much and the concentration of volatile acidity was not high during all transformations[21]. During the preparation of Marsala-type wines, enzyme preparations Vinozim and Ultrazym were used. More optimal options for using enzyme preparations were identified. A new technology for preparing vacuum juice as a blending component was given[22]. There are 29 different Marsala categories on the market, depending on the grape variety, production technology and aging. A study was conducted to develop a fast and easy method to characterize the different categories using Fourier transform infrared (FTIR-ATR) spectroscopy in addition to multivariate analysis. aims. The proposed method is promising because it is simple and fast and does not require any pre-treatment steps of the sample. Moreover, it is environmentally friendly because no organic solvents are used[23]. This review provides an overview of the traditional winemaking process, including the microbiota and autochthonous yeasts, as well as regulatory aspects of the main Italian, Portuguese and Spanish wines. The winemaking process is essential for identifying the volatile organic compounds (VOCs) that characterize the aroma of each fortified wine, giving it an organoleptic fingerprint and "terroir" characteristics. The various volatile and aromatic compounds found during oxidative aging in fortified wines are discussed in the final section of this review[24].

Marsala wine is the oldest of the Sicilian wines and takes its name from the small town where it is produced. It is one of the most famous fortified wines in the world due to its organoleptic qualities and incredible versatility. Despite its ancient origins and the fame that has made this wine known all over the world, Marsala wine has been in decline for several years. This is due to the emergence of new strong competitors (Passito wine, Malvasia wine, etc.)[25]. To obtain the first map of lactic acid bacteria colonizing Marsala wines, "Grillo" grape varieties were harvested from five vineyards, differing in climatic and agronomic parameters. The large-scale production of Marsala-based wine was followed and samples were collected from the winery to the bottling. The effect of lysozyme and SO2 on lactic acid bacteria was also evaluated through two experimental micro-vinification processes. In conclusion, this study, in agreement with previous studies, highlights the lack of antimicrobial activity of lysozyme and SO2 against Lactococcus lactis subsp.[26]. Fortified wines are classified together due to their high alcohol content. Wine spirits are added to them at some stage during production. They are consumed with food due to their flavor intensity, usually served as aperitifs or desserts. The most common fortified wines are Port, Sherry, Madeira, Moscatel and Marsala. Monomer anthocyanins in young red wines from grapes contribute to most of the color and health benefits associated with their consumption, and are therefore recognized as one of the most important groups of phenolic metabolites in red wines. The degradation of anthocyanins depends on several factors, namely temperature, pH, sugars, oxygen availability, and ethanol content[27,28]

Numerous studies have been conducted in relation to the improvement of the production technology and the quality of Marsala wines. Nevertheless, those studies are not at a level that fully provides the solution to the mentioned issues.

Materials and methods.

Grapes, juice, comb, pomace, perennial part of the vine, wine materials, auxiliary materials, etc. were taken as research objects. White grape varieties are used in the research. In order to carry out the harvest on time, the maturity of the grapes was regularly monitored, the sugar-acid index, phenolic ripeness and the amount of anthocyanins were determined. The sugar content was maintained in the grape berry in the range of 18-22 g/cm3, depending on the variety's ability to accumulate sugar. Local and introduced white grape varieties were selectively harvested and brought for processing after a sufficient amount of sugar accumulated in the grapes. Harvested grapes were cleaned of diseased and damaged berries and processed using various technological methods. In order to obtain a homogeneous mash mass, berries were completely crushed. Then, SO2 was injected at the rate of 30-50 mg/dm3 and the mash was left untouched. For fermentation of the samples in the mash, processing with heat and enzyme preparations, etc. the mash mass was divided into equal-weight portions. The components to be used in the coupage were prepared in the following order:

1. Sour alcoholized wine material was prepared by two methods: In the first method, the juice was fermented in the mash, pressed and the mixture of all fractions was alcoholized. In the second method, the mash was treated with heat, then it was cooled and pressed, and all the juice fractions obtained were mixed, fermented and alcoholized up to 18.5 h%.
2. Alcoholic juice (mistelle) – the mash was fortified up to 14 h% in hermetic reservoirs. After storage for 1 day, it was pressed and all the fractions obtained were mixed and alcoholized to 18% using 96% ethyl alcohol.
3. Alcoholized dense juice (pekmez)- dense juice obtained from the used grape variety was alcoholized up to 35-40 h% in hermetically closed reservoirs and stored for 6 months with the heat processing at a temperature of 45-500C while being mixed for 1 hour every day. The main constituent indicators and their change patterns were studied with the help of generally accepted, new, and modified analysis methods widely used in enochemistry [29]. The statistical analysis was carried out using the program SPSS18 package [30].

The purpose of the work is to study the influence of various technological methods on the composition and quality of the components of the coupage used in the preparation of Marsala-type wines.

To achieve this goal, the following tasks are to be solved:

- Study of raw materials and choosing a grape variety;
- Effect of maceration and fermentation in the mash on the composition of coupage components;
- Effect of thermovinification and the Kakhetian method on the composition of coupage components.

Results of the research and their discussion

Wine samples made by fermentation in the mash and heating of the mash from aboriginal and introduced white grape varieties were comparatively analyzed (Fig.1 and Fig. 2). As seen, the amount of phenolic compounds was higher in the Rkatsiteli variety compared to other samples. A similar situation was detected in the amounts of extracted substances. According to these indicators, the Rkatsiteli wine sample was followed by the white Sauvignon, Semillon, and finally the Bayanshire grape variety. The mash was heated at 60^0C for 1.5 hours, and after cooling to room temperature, it was fermented. Fermentation was carried out to the end as in the previous experiments, and then the mash was separated by compression. The separated wine material samples were alcoholized using the same procedure as previously. It was found that the amount of phenolic compounds and the sugar-free extract in these samples increased significantly compared to the previous experimental samples. The amounts of phenolic compounds in Marsala coupage components prepared by various technological methods were significantly different.

As seen in the figure, the amount of phenolic compounds in the samples prepared by fermentation in the mash varied between 280 and 640 mg/dm^3. Whereas, a significant increase occurred in the amount of phenolic compounds in the samples prepared by heating the mash and this value increased to 310-670 mg/dm^3. However, it should also be noted that the samples obtained by heating the mash were infused longer and some phenolic compounds were sedimented. For Marsala wine, it is important that the coupage component is enriched with sugar-free extract (Fig. 2).

In the samples prepared by fermentation in the mash, the amount of sugar-free extract was minimal in the Bayanshira variety (19.5 g/dm^3), followed by Semillon (21.2 g/dm^3), Sauvignon (21.7 g/dm^3), and Rkatsiteli (23.6 g/dm^3). Whereas, in the wine samples prepared by heating the mash, an increase of 2-7 g/dm^3 was observed in the amount of the extract compared to the previous method.

In this series of experiments, the amount of sugar-free extract was the smallest in the wine samples obtained from the Bayanshira grape variety and the largest from the Rkatsiteli grape variety. Wine samples were prepared from the Rkatsiteli grape variety using different technological methods.

Regardless of the technological method, in all cases, the fermentation was carried out to the end, and the obtained sour material was alcoholized using rectified ethyl alcohol. The alcohol content was between 18.5 and 20.5 h%.

First, the physicochemical and organoleptic indicators of the coupage components prepared by maceration and fermentation of the mash were analyzed (Fig. 3).

The amount of sugar-free extract increased by 1.5 g/dm^3 during 12 hours of storage in the mash, and by 2.9 g/dm^3 during 24 hours of storage in the mash, compared to the control. The highest, 25.1 g/dm^3, indicator was detected in the sample fermented in the mash. Increases in polysaccharides, pectin substances, esters, phenolic compounds, and nitrogenous substances were observed in the same sequence. The opposite was observed regarding cloudiness. In other words, the clearest sample was obtained in the white method (control), and there was an increase in cloudiness due to increasing contact with the mash. According to the results of the organoleptic assessment, the indicators of the experimental samples were higher by 0.05-0.20 points compared to the control. Samples of sour wine were prepared from the Rkasiteli grape variety using heat processing and the Kakhetian method and alcoholized by the same techniques. The results obtained are given in Table 1.

As seen in the table, in this series of studies, coupage components were prepared by the white method (control), thermovinification and the Kakhetian method. Thermovinification was performed in two variants. In the first case, the mixture was heated at 60^0C for 1.5 hours, cooled and fermented. Fermentation continued until the end. The mixture was heated to the designated temperature and then cooled to room temperature.

Then it was pressed and fermentation was carried out in the juice. As it is known from the name, fermentation was carried out together with a comb in sample preparation by the Kakhetian method.

As seen in the table, there was a 1.0-1.5 fold increase in the amount of sugar-free extract in the experimental variants compared to the control.

This indicator reached its peak in the sample made by the Kakhetian method. The amount of nitrogenous compounds in the coupage components changed as shown in the diagram (Fig. 4).

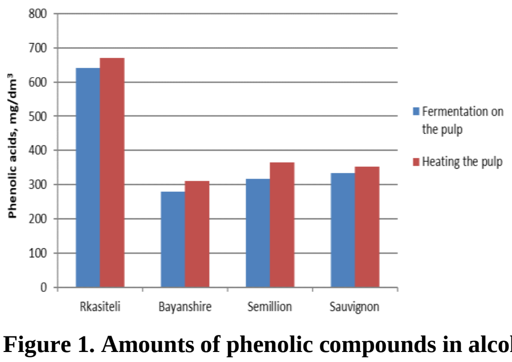


Figure 1. Amounts of phenolic compounds in alcoholic sour wine samples

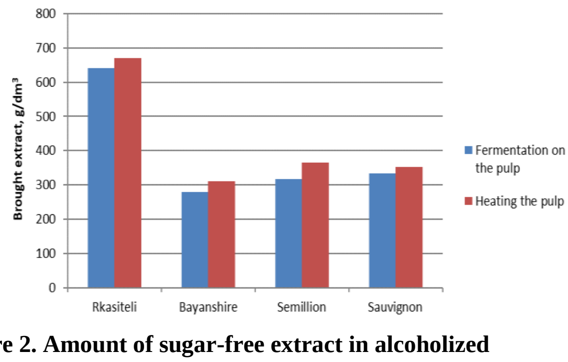


Figure 2. Amount of sugar-free extract in alcoholized sour wine samples, n=6, p<0.05

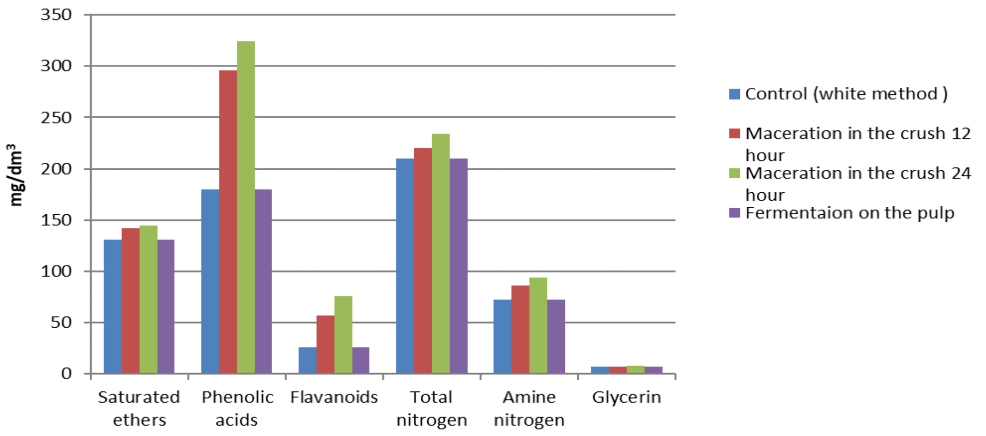
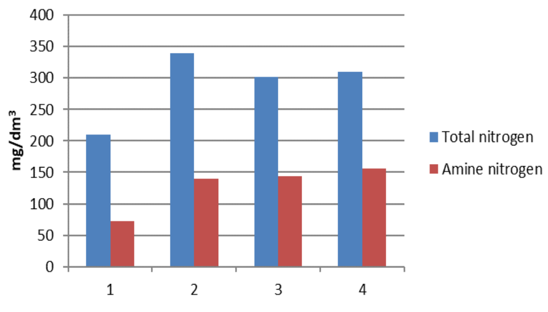


Fig. 3. Effect of different technological methods on the quantity of extract substances, n=6, p<0.05

Table 1 – Physicochemical and organoleptic indicators of alcoholized sour wine materials obtained by thermovinification and the Kakhetian method (Rkatsiteli variety), n=6, p<0.05

Indicators	Methods of obtaining wine material			
	Control (white method)	Heating the pulp at 60°C for 1,5 hours		Kachet method
		Fermentation of the bruise	Juice fermentation	
Alcohol, %	19,4	20,05	20,10	20,15
Sugar, g/100 sm^3	0,7	0,9	0,6	0,7
Titratable acidity, g/dm^3	6,1	5,8	6,0	6,4
Volatile acids, g/dm^3	0,51	0,60	0,66	0,56
Brought extract, g/dm^3	16,8	29,5	27,7	32,8
Polysugars, mg/dm^3	330	890	540	810
Pectin substances, mg/dm^3	46	122	88	105
Saturated ethers,mg/dm^3	131	160	154	150
Phenolic acids, mg/dm^3	180	690	580	850
Flavanoids, mg/dm^3	26	210	108	170
Glycerin, mg/dm^3	7,2	6,3	6,5	6,1
pH	3,4	3,6	3,1	3,5
The blur	0,3	2,2	1,4	2,1
Evaluation of wine material, score	7,40	7,95	7,90	7,85

As seen, an increase in the amount of both representatives of nitrogen was observed in the experimental variants compared to the control. The highest increase in the amount of total nitrogen was in the second variant, followed by the fourth variant. The amount of amino nitrogen in the fourth variant was slightly more noticeable than the others. Studies were performed for the preparation of another coupage component, that is, mistelle, from the Rkatsiteli grape variety. Different technological methods were used for this purpose. Physicochemical and organoleptic characteristics of alcoholized juice obtained by maceration of the mash are given in Table 2. As seen, the juice was made in four variants. The white method involved keeping in the mash for 12, 24, and 48 hours. SO_2 in the amount of 30-50 mg/dm3 was added to the mash and the temperature of the mash was adjusted between 10-15^{0}C in order to prevent fermentation during the storage period.



1 - control (by the white method); 2 – fermentation of the mixture with heat at 60^{0}C for 1.5 hours; 3 - fermentation of the juice obtained by squeezing the mash after heat treatment at 60^{0}C for 1.5 hours;4 – Kakhetian method.

Figure 4. Changes in the amount of nitrogenous substances in coupage components obtained by different technological methods, n=6, p<0.05

The samples, which differed in terms of storage time, were pressed separately and the juices obtained were alcoholized up to 18.5-20.5 h%. It was found that the amount of sugar-free extract increased with the length of time the mash was stored and reached its peak in the "48-hour storage" variant. Similar dynamics can be observed in the amount of total and amino nitrogen. However, there was a decrease in the amount of phenolic compounds in variant IV. Regarding the organoleptic evaluation, the IV variant received the highest point. Thus, the sample prepared for this variant was higher by 0.35 points compared to the control, that is, 7.70 points.

Other technological methods for obtaining alcoholized juice, including the white method, processing of the mash and juice at 60^{0}C for 1.5 hours, and short-term heat processing of the whole bunch were studied (Table 3).

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Table 2 – Physicochemical and organoleptic parameters of alcoholized juice (mistelle) obtained by maceration of the mash (Rkatsiteli grape variety), n=6, p<0.05

Indicators	Obtaining methods of wine material			
	Control (white method)	Maceration in the crush		
		12 hour	24 hour	48 hour
Alcohol, %	19,7	20,0	20,0	20,02
Sugar, g/100 sm^3	20,03	20,0	20,01	20,0
Titratable acidity, g/dm^3	5,2	5,4	5,6	6,3
Volatile acids, g/dm^3	0,14	0,18	0,20	0,24
Brought extract, g/dm^3	16,1	17,6	19,1	25,6
Polysugars, mg/dm^3	470	510	560	662,5
Pectin substances, mg/dm^3	94	110	116	120
Saturated ethers, mg/dm^3	36	40	44	50
Phenolic acids, mg/dm^3	230	360	380	340
Flavanoids, mg/dm^3	46	90	106	86
Total nitrogen, mg/dm^3	270	290	310	380
Amine nitrogen, mg/dm^3	110	130	140	160
Ammonia nitrogen,mg/dm^3	16,4	17,1	19,2	22,2
Protein, mg/dm^3	19	21	22	25
Glycerin,g/dm^3	0,6	0,7	0,8	0,8
pH	3,5	3,2	3,4	3,2
The blur	1,5	1,9	2,0	2,4
Evaluation of wine material, score	7,35	7,55	7,60	7,70

Table 3 – Physicochemical and organoleptic indicators of alcoholized juice (mistelle) made by thermovinification (Rkasiteli grape variety), n=6, p<0.05

Indicators	Obtaining methods of wine material			
	Control (white method)	Heating the pulp at 60°C for 1,5 hours		Hot processing of whole bunch
		Hot processing of the crush	Hot processing of the juice	
Alcohol, %	19,7	19,8	19,9	20,1
Sugar, g/100 sm^3	20,03	20,02	20,0	20,04
Titratable acidity, g/dm^3	6,3	5,0	5,1	7,4
Volatile acids, g/dm^3	0,24	0,32	0,36	0,26
Brought extract, g/dm^3	25,6	32,4	26,7	29,5
Polysugars, mg/dm^3	662,5	810	720	770
Pectin substances, mg/dm^3	120	176	141	165
Saturated ethers, mg/dm^3	50	70	67	53
Phenolic acids, mg/dm^3	340	710	390	570
Flavanoids, mg/dm^3	86	130	110	150
Total nitrogen, mg/dm^3	380	430	400	410
Amine nitrogen, mg/dm^3	160	200	190	210
Ammonia nitrogen,mg/dm^3	22,2	7,8	7,3	23,2
Protein, mg/dm^3	25	16,3	17,1	31,2
Glycerin,g/dm^3	1,2	0,6	0,7	0,5
pH	3,2	3,6	3,4	3,3
The blur	3,0	4,5	4,0	3,5
Evaluation of wine material, score	7,70	7,85	7,80	7,90

Table 4. Physicochemical characteristics of alcoholized bekmez samples, n=6, p<0.05

Content indicators	Examples			
	1	2	3	4
Alcohol, %	40,32	39,60	40,01	41,30
Water-soluble solids, Brix°	49,08	51,05	47,33	50,22
Sucrose, %	1,02	00	00	1,1
Total ash, %	1,40	1,62	1,65	1,55
pH	4,64	4,78	4,56	4,85
Hydroxymethylfurfurol, mg/kg	5,35	4,14	2,88	4,02
Formol number	13	9	11	8
Titratable acidity, %	0,43	0,36	0,39	0,41
Metals, Ppm:				
Arsenic	0,11	0,10	0,09	0,11
Copper	3,4	2,9	3,7	3,5
Zinc	3,0	3,1	2,9	3,3
Ferrium	11,0	10,3	11,2	10,8
Tin	120,4	116,5	122,1	110,7
Lead	0,12	0,10	0,11	0,10

The amount of phenolic compounds, which are the main constituent indicators, was higher in the heat processing of the mash. This amount was 390 mg/dm^3 during the heat processing of juice, and 570 mg/dm^3 during the heat processing of the whole bunch. During the organoleptic evaluation, the heat processing of the entire bunch was the highest with 7.90 points. It was accompanied by a sample of the heat processing of the mash with a score of 7.85.

Bekmez obtained from the Rkatsiteli grape variety according to variants was alcoholized up to 40 h% and thoroughly mixed. Alcoholized bekmez was heated to 45-50^{0}C, kept and ripened in a thermostat for 6 months with stirring for one hour every day. During the heat treatment, the reaction between amino acids and reducing sugars (formation of melanoidins) takes place in the alcoholized bekmez, which is very important for the future Marsala (Table 4).

As seen, the amount of water-soluble dry matter in the samples varied between 47.33 and 51.05%. Formol number was 13 in the first sample and varied between 8 and 11 in other samples. In this case, the indicator with the lowest value was observed in the fourth variant. The amount of metals, especially arsenic and lead, changed within the norm, being much less than unity. The amount of arsenic changed between 0.09 and 0.11 and the amount of lead between 0.10 and 0.12 ppm

Conclusion

1. The research revealed that the amount of sugar-free extract and phenolic compounds in wine samples made from the Rkatsiteli variety is higher than in the samples obtained from other grape varieties. According to these indicators, it is followed by white Sauvignon, Semillon, and finally, Bayanshire grape variety. This served as the foundation for choosing the Rkatsiteli grape variety as the main raw material for further research.

2. Wine samples were prepared using the white method (control), by keeping them in the mash for 12 and 24 hours, as well as fermentation in the mash and then they were alcoholized. The amount of sugar-free extract showed an increase of 1.5 g/dm^3 during 12 hours of storage in the mash, and 2.9 g/dm^3 during 24 hours of storage in the mash compared to the control. Although the highest indicator (25.1 g/dm^3) was observed in the sample prepared by fermentation in the mash, the samples obtained by thermovinification and the Kakhetian method were distinguished by richer extractability.

3. An increase in the amount of polysaccharides, pectin substances, saturated ethers, phenolic compounds, and nitrogenous substances was noticed in the mentioned sequence. Due to its cloudiness, the opposite was observed. In other words, the clearest sample was obtained in the white method (control), and there was an increase in cloudiness due to increasing contact with the mash. According to the organoleptic assessment, the indicators for the experimental samples were higher by 0.05-0.20 points compared to the control.

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