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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

IMPROVING OF THE TECHNOLOGY OF JUICES AND WINES WITH THE USE OF CRYOTHERAPY

Specialty: **3309.01- Food production technology**

Field of science: **Technical sciences**

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GENERAL DESCRIPTION OF THE RESEARCH

Relevance and degree of completion of the topic. The organization of large-scale export and sale of wine products, especially high-quality wine, in Azerbaijan has great prospects. In this regard, in recent years, a lot of work has been carried out in the republic in the field of zoning and specialization of viticulture on the basis of the principle of more efficient use of natural and economic resources of districts and villages. On a large scale, the reconstruction of production, improvement of the assortment in garden construction, improvement of the level of agricultural machinery in the mechanization and cultivation process are carried out.

Nevertheless, the improvement of the quality of wine products, the continuous improvement of technological processes in this area, the introduction of scientific and technical achievements are still important problems. Of particular importance in solving this problem is to increase the resistance of wine to turbidity.

To assess the wine's resistance to tartar sediment, a method based on changing the amount of tartaric acid is used. However, for model wines, the calculation of tartaric acid, the amount of solubility, the dissociation constant in the wine-alcohol product, and the prices obtained per percentage were favorable for practical application. The influence of numerous components on the crystallization process in wine distorts the obtained patterns. One of the progressive methods of ensuring the stability of grape juice and wine to crystalline and colloidal turbidity is based on the use of cold.

In winemaking, the use of cold is usually associated with ensuring the stability of the wine to crystal and colloidal turbidity. This treatment is carried out at a temperature close to the freezing point. The wine has not yet frozen, although at this time numerous crystals are formed in the wine. However, the possibilities of low temperatures (below freezing), including freezing (cryotreatment, cryoeffect), are much greater. Their use not only ensures the durability of the packaging, but also leads to an increase in the volume fraction of ethanol. However, despite the existing positive experience, in the wine industry of the republic, it is still used, as before, due to the lack of scientifically based technology. In this regard, it is considered relevant to study the effect of cryoeffect of table wines on its physico-chemical, organoleptic parameters and the stability of packaging and the justification of cryoemal regimes.

Purpose and objectives of the study. The purpose of the study is to substantiate the technological parameters of the production of grape juice and wine using cryotherapy.

The objectives of the study include:

- substantiation of theoretical considerations of cold wine processing;
- study of the effect of cold in natural conditions on the chemical composition of various wine materials;
- justification of the modes of cold processing of wine materials;
- study of the organoleptic and biological resistance of wine materials to cold;
- hardware justification of the technology of cold processing of wine materials;
- assessment of the economic efficiency of wine production based on improved technology.

Research methods. Juice, wine materials and wines obtained from white and red grape varieties grown in the republic, the technology of their preparation and cryotherapy, the cooling process and hardware were taken as the object of research. To solve the problem before us, a system-technological approach was applied, including the analysis of the product at all stages of the production cycle.

Main provisions to be submitted for defense:

- theoretical analysis of the time and energy spent in the process of cold processing of juice or wine material at freezing temperature;
- technology and storage modes of step freezing in terms of quality and energy saving of cryostatic processing of wine materials;
- technical and technological solution of an experimental crystallizer that processes white and red wine materials with cryogas and prepares the cryogas of the compasses for champagne;

- the nature of the change in the amount of sugar and ice during cryogenic processing without step-by-step cold processing and operating modes;
- the nature of the changes in the chemical composition of white and red wine, processed bioeffector
- experimentally established prices of the chemical composition and technological parameters of champagne wines produced by the cryo effect;
- hardware and efficiency of cryo technology application.

Scientific novelty of the research. The expediency and effectiveness of cryotherapy to improve the quality and durability of wine materials is scientifically theoretically justified and confirmed experimentally. The regularity of changes in the physical and chemical parameters of grape juice during its freezing is established. A significant increase in biologically active substances in the frozen concentrate was found. New data have been obtained on changes in the composition of amino acids, phenolic and aromatic compounds, as well as organic acids and their salts under the influence of cold in both white and red wines. The technology and technical support for cryostatic processing of wine materials are developed at the level of a utility model and approved by the State Committee of the Republic of Azerbaijan for Standardization, Metrology and Patents, the Central Public Legal Entity for Patents and Trademarks (Az Patent) as a utility model **(U 2019 0056)**. Effective freezing of grape juice is established and confirmed by the fact that the three-stage freezing of pre-glued juice prevents its enrichment with oxygen in the air.

Theoretical and practical significance of the study. Theoretical analysis of the process of wine processing by cold, including the coagulation and precipitation of protein and pectin substances, their absorption by various small particles contained in wine, a wide variety of bacteria, mold spores, the absorption of wine by oxygen, improving taste and quality, considerations about processing modes are of theoretical importance for research on the use of cryo technology in the preparation of food products.

Of practical importance for the wine industry is ensuring the stability of grape juice and wine to crystallization, colloidal turbidity, resistance to pouring, justification of cryotherapy regimes, development of improved technology and technical means, experimental justification of its rational parameters of the regime.

Approbation and application of works. The main provisions of the dissertation were considered at the international scientific and practical conference " Modern agricultural science: current problems of the century and prospects for development in the context of globalization”(Ganja, 2014), XIV Republican Scientific Conference of undergraduates dedicated to the 91st anniversary of the birth of National Leader of the Azerbaijani People Haydar Aliyev (Sumgait, 2014), Scientific and practical conferences of ASAU (Ganja, 2014). 2014-2020), at the international scientific conference on "Current problems of modern natural and economic sciences” (GSU, Ganja, 2018), reports at the II Republican scientific and practical conference” Prospects for the development of the food and textile industry in our republic and the upcoming tasks “(Baku, 2018), at the international scientific conference "Scientific support for the development of JSC in the context of import substitution" (St. Petersburg, 2020).

A technology for making natural wine with the effect of cold has been developed, and an experimental setup for its hardware has been developed. The developed technology was tested in production conditions and applied at the juice and wine processing plant of Az-Granata LLC. The economic effect was 6913 manat per 1000 bottles.

The name of the organization where the dissertation work is performed. The dissertation work was carried out at the department of " Engineering and examination of food products” Azerbaijan State Agrarian University.

The total volume of the dissertation with an indication of the volume of the structural sections of the dissertation separately. The dissertation work consists of an introduction, four chapters, a conclusion, a list of references in the amount of 140 pieces and appendices. There are 20 figures, 28 tables and 2 appendices. Content of thesis introduction contains 5 pages, and 9511 of characters that first chapter 21 pages and 40881 sign, second chapter 11 pages and 17207 signs, third chapter 12 pages and 19814 characters, the fourth chapter 72 pages and 111236 signs, conclusions 2 pages and 3267 characters, recommendations for production 1 page and 401 characters, references 140 numbers 15 pages and 25306 characters. The volume of the dissertation is 146 pages of computer text, the total volume is 233058 characters (25329 characters excluding the list of references and appendices).

CONTENT OF THE WORK

In the introduction, the relevance of the topic, the problem statement and the general characteristics of the dissertation are given.

First chapter. This chapter is entitled "Statement of the problem, goals and objectives of the study", the features of the use of the cold effect in winemaking, the place of heat treatment in wine technology, the analysis of methods for preparing thickened grape juice, the state of the study of the process of freezing wine. At the end of the chapter, the goals and objectives of the study are indicated.

In winemaking, cold is usually used against crystalline and colloidal turbidity of wine materials. This treatment is carried out at a temperature close to the freezing point, at which the crystal particles (rusheimi) are just beginning to form, but the wine does not freeze. When the wine is cooled below freezing, small ice crystals form in the liquid. It is water that forms such crystals. Because many of the components of alcohol and wine is not solidify at a lower temperature.

On the cooling technique for freezing wines and juices.A. Alekseev and N. A. Moiseyev, who gives, is quite remarkable.

As a result of these studies, a number of technical tools were developed. But the proposed devices have the following disadvantages:

- ❖ crystallizer, separator, ultrasonic cooler, mixing bowl and other expensive equipment make the freezing process significantly more expensive;
- ❖ when mixing in all the units of the freezer unit, the juice is subjected to excessive aeration. It also negatively affects the quality of cryoconcentration and, consequently, of the finished product.

The analysis carried out in the framework of research works shows that the technology of cryogatization is not sufficiently studied in winemaking. There are few data on the use of this technology.

All this, thanks to research in the field of application and improvement of cryogenization technology in the production of table wines and other types of wines, can serve to obtain a high-quality product on this basis, and expand its range.

Second chapter is entitled It is called "Justification of the theoretical considerations of cold wine processing", which provides a critical analysis of the technical means from the point of view of the theoretical and cooling considerations of the cold wine processing process.

Cooling the wine gives various side effects as a result of its physical, chemical, biological and chemical effects. It is known that lowering the temperature of the room in which the wine is stored leads to the precipitation of tartaric acid salts in it. The same effect, but in a shorter time, is obtained by artificially cooling the wine in the refrigerator. The physical and chemical effect on the wine makes it resistant to further precipitation of tartaric acid salts and disruption of the balance of its composition with a drop in temperature in the room. Cooling also contributes to the precipitation of other salts, additives and dyes, and the coagulation of protein and pectin substances. Their presence in the wine makes it difficult to clean young wines. Colloidal pectin substances, passing into a liquid state in wine, can not only create turbidity, but also prevent the formation of sediment. Because protein and pectin cause substances to curdle and precipitate, the cold has almost certainly carried out its own sticking to the wine. By coagulating, pectin and protein attract small particles of various substances contained in wine, a wide variety of bacteria, mold spores and other microorganisms that are always found in wine.

Observations show that during crystallization in wine, crystals of different sizes are formed, which fall off at different rates. This speed depends on the size of the crystal and the density of the wine. So, the case of the fall of the tartar is as follows. Initially, microscopic small crystals are formed, which gradually grow (increase), some of them branch out. Less-very large crystals and branched ones crumble at such a speed that they can be seen with the naked eye. And small crystals remain in the liquid in a suspended state, and if they crumble, the rate of their deposition is very small. In addition, the crystals dissolve with a slight increase in the temperature of the wine. They are able to easily pass through the filter cloth and create turbidity by recrystallizing in the wine filtered through a transparent filter.

Third chapter under the title Objects of research and methods of experimental research ", where the characteristics of the objects of research and methods of research are given.

Technical grape varieties Bayanshire, Risling, Shardone White and Saperavi Red were used as research objects for the fermentation of grape juice by cold processing. The characteristics of these grape varieties are given in table 1.

Table 1

Characteristics of the studied grape varieties

Variety	Maturation period	The mass of bunches g	The shape and size of the fetus	productivit, c/ha	Mass concentration, q/dm^3	
					Sugar	Titratable acidity
Bayanshire	Later rape	201,3	Round, medium-sized	177,8	171	17,1
Risling	Average later rape	86,6-112,8	small and medium sizes	53,3-84,4	186-223	5,6-7,4
Shardone	Average rape	110-160	Small-weak oval, small-medium	60-120	170-230	6,56-8,26
Saperavi Red	Later rape	140-236	Oval -medium	62,2-128,8	182-226	5,26-7,46

We can say that the decisive factor in the formation of not only the quantity, but also the quality of the processed product is the grape variety. When choosing a variety for harvesting grapes, you should be guided by the technological and regulatory documentation that corresponds to a particular type of product.

When harvesting technical grape varieties for winemaking, it is necessary to observe what is recommended in the technological recipes. If a coefficient is also provided for champagne, then the sugar content in the grapes of the harvest should be at least 160 g/dm^3, and the titrated acidity-7-9 g/dm^3. Even if a thickening operation is provided, the sugar content should be at least 170 g/dm^3, and the mass concentration of the titrated acidity-4-7 g/dm^3. As can be seen from table 1, for grape varieties grown in the regions, these indicators are at the level corresponding to demand.

Sulfur dioxide was used as an antioxidant to produce a wine material that was condensed cold from grape juice. Sulfur dioxide was pumped into the juice at the rate of 100 mg/dm^3. For this purpose, sulfur gas dissolved in the juice was introduced. This is done by adding 1 kg of liquid sulfur dioxide to 10 liters of fresh juice.

For re-fermentation, a solution of liquid yeast Saccharomyces was used. Such a race of yeast is resistant to acidity.

The main components of the chemical composition of wine materials-the volume fraction of ethyl alcohol; the mass concentration of sugars, titrated and volatile acids, imported extract, sulfur dioxide, as well as the organoleptic analysis of wines were carried out by methods contained in the current standards (GOST R).

Fourth chapter named "Experimental studies and their results," where is the substantiation of the scheme improvements cryotherapeutic experimental setup, the choice of the technological scheme of processing of juice and wine with cryotherapy, the rationale for the mode of operation, the study of the relationship between factors affecting a process evaluation of the effect of low temperatures on the quality of grape production, the rationale of workers and the quality parameters of technology natural table wine with the use of cryotherapy, a report was presented on the cost-effectiveness of the research and application of methods for the application of sugar technologies in the developed technology.

There are a number of technologies and technical means that process wine with the cryo effect. The disadvantages of this technological equipment are considered the main factor that complicates their pro-duction application. The disadvantage of these devices is that the blades that separate the ice from the surface of the tubular freezer (heat exchanger), at a fixed distance, only tear the ice layer from the surface, which leads to spots on its surface, and not in the form of pulsating crystals. Since it is more likely that ice that is not in this pulsating crystalline state can easily melt and turn into yeast, it is necessary to pass the product through recycling, which reduces the productivity of the plant. At the same time, the freezing intensity of the new liquid entering through the layer decreases, as the thermal resistance increases, since a layer of ice is constantly left on the pipes.

Taking into account the above, in the course of research, the cryostatic installation was improved. The experimental cryostat unit containing the improvement elements consisted of a crystallizer, schematically shown in figure 1. The device works as follows.

Through the neck-30 into the container-6, and from there, passing through the holes of the distributor-5, the product (wine material) is fed to the pipes-1. The liquid under its weight in the form of a film-34 is poured into the collection vessel-4. With the help of a cooling pump -24, the agent is fed into the tubes-2 with the help of a receiver-25 and is poured through the tubes-1 in the form of a film-35.The liquid refrigerant is pumped by the pump-24 into the pipes-2. The refrigerant vapors are collected by the compressor of the receiver-25 and pumped into the condenser-27. Here it is poured into the receiver-28 line in the form of condensed liquid refrigerant. From here, the throttle valve-29 is regulated and fed to the circulation receiver-25. From this receiver, the throttling gases-25 are fed to the compressor-26, the liquid refrigerant enters the pump-24. This is the end of the refrigerant cycle.

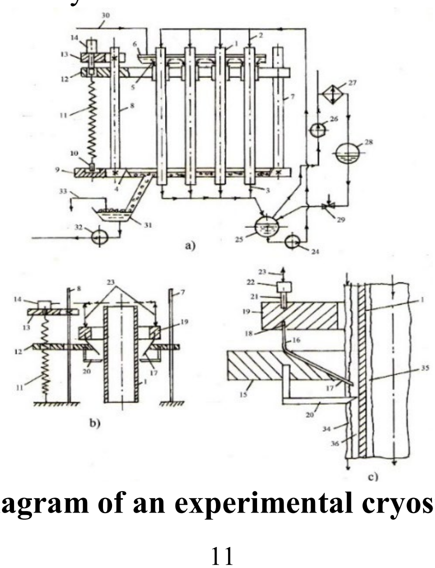

Figure 1. Diagram of an experimental cryostatic installation.

The wine material is fed into the tube 30 of the receiving tray-6. From here, it is discharged through the distribution holes-5 from the outer surface of the heat exchanger of the vertical pipes-1. When the liquid film 34 flows through the surface of the upper and lower tubes-1, heat to cool and warm phases of the conversion gain from the liquid product, while the pair separated from the liquid refrigerant-35, circulate in the receiver -25 circulates through the tube 1 in the lower part and is applied to the product film outer surface of the tube to form a layer of ice (crystal) -36. The condensed wine material enters the next collection tank-4, from where it is transferred to the general collector-31, and then using the pump-32, the condensed wine material is transferred to the next stage of use or storage. The condensed wine material flows into the next tray for collecting the product-4, from where it is sent to the general collection-31, and from there by the pump-32 to the next stage of use or storage. Under normal operating conditions, when a layer of ice-36 forms on the surface of the pipe-1, blades 16 and 20 are used to cut it. They are connected to the transmission mechanism-14 and work through it. When the transmission mechanism-14 is activated, the hydraulic fluid is pumped into the pipeline-23 and the transmission-22, as a result of which the bearing ring-19 is located on the rod-21. In this case, the elastic razor 17 blade-16 attached to it moves down with the profiled inner surface of the support ring-15. The razor-17 penetrates the ice layer-35 to the appropriate depth (provided that it does not come into contact with the wall of the pipe-1, otherwise these blades-16 can stick to the surface of the pipe-1, because the razor is the width of a scraper). At the same time, the transfer mechanism-14 rotates the drive screw-11, which is kinematically in contact with the moving plate-12, and the pillow-10 sits. The movable plate-12 moves down along the support columns-7 and 8. The profiled ring-15, connected to the movable plate-12, also moves along the pipes-1. It cuts through the ice-36 layer and separates it from the surface of the pipe-1 in the form of scales. The ice flakes are poured into the tray-4 and from there, together with the condensed wine material, are transferred to the general collection. From here, the pieces of ice are extracted by the ice collector-32 and put into technological use. This completes the work on the wine material (product) of the device. When the movable plate-12 reaches the lower limit position, the reverse of the movement is provided by the transfer mechanism-14. In this case, the movable plate-12 returns to the upper position. With the onset of reves, the integral-22 rod 21 reaches the upper position with the ring carrier 19, the blade-16 and the razor 17 are separated from the surface of the pipes from the inner surface of the profiled support ring -15, allowing the wine material to flow through the surface of the pipe-1. When the movable plate-12 reaches the upper limit, the integral mechanism-14 stops until the second cycle of the icebreaker begins. The operation of the device for cutting and separating the ice layer-36 is completed. Based on a critical analysis of existing technological schemes and designs, it is more appropriate to consider three-phase freezing (obtaining ice crystals) to obtain thickened grape juice or wine material by cold (freezing).

In the experimental technological version, the juice of the Riesling grape variety was taken to determine the modes and optimal parameters of freezing (duration, number of tiers, sugar content in the cryoconcentrate and ice, mass of frozen ice) and the efficiency of the system. In practice, it is customary to freeze in three stages and determine the specified parameters every 0.5; 1.0; 1.5; 2.0; 2.5 hours. The first tier was performed after freezing, the second, and then the third tier-freezing. Every 0.5-1 hour, measurements were made on each tier according to certain parameters and modes. The results of the experiment are shown in table 2 and figure 2.

Table 2

Qualitative indicators of the thickened product and ice when freezing Riesling grape juice at different stages (the amount of the initial juice is 10 dal, the mass concentration of sugar is 188 g/dm^3)

Indicators	Steps		
	I	II	III
Amount of frozen juice, dal	7,3	5,3	4,7
Mass concentration of sugars in concentrated juice, g/dm^3	254	348	390
Amount of ice, dal	2,7	2,0	0,6
Mass concentration of sugars in ice, g/dm^3	5	6	8

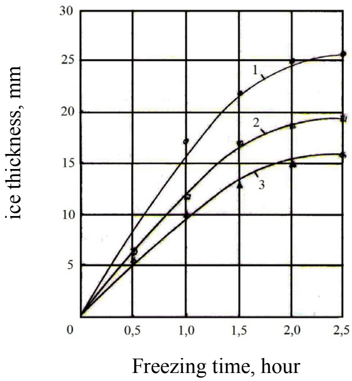

Figure 2. Change in ice hardness depending on the freezing time: 1-at the I stage; 2 - at the II stage; 3 - at the III stage.

As soon as the freezing point was determined, the formation of ice at all stages was first intense (fig. 2), and then the intensity decreased. This is due first to the absence of a layer of ice on the surface from which the ice was formed, and then to the presence of an ice sheet. At the first stage, the freezing time should preferably take 1.5-2.0 hours. The thickness of the ice at this time reaches 25 mm. After that, the continuation of the process cannot be considered effective. In the initial processing of juice with a mass concentration of sugars of 188 g/dm^3 at the first stage, this indicator was 254 g/dm^3.

The study of the effect of cold processing on the chemical composition of grapes showed that there were significant changes in this process (table 3). It turned out that cryotherapy for both varieties showed a decrease in sugar content, titratable acidity, Volatile acidity, phenolic substances and proteins.

Table 3

The effect of cold processing on some indicators of the chemical composition of grape juice

Indicators of the composition	Grape varieties			
	Bayanshira		Risling	
	Starter juice	After processing	Starter juice	After processing
Shugar, g/dal	18,2	28,4	19,4	31,6
Titratable acidity, g/dm^3	6,3	7,1	6,7	8,1
Volatile acidity, g/dm^3	0,16	0,17	0,19	0,19
Phenolic substances, mg/dm^3	176	242	210	271
Protein, mg/dm^3	80	77	72	69

With the help of a refrigerator, the wine material was cooled to -8 ...- 10^{0}C and treated with cryotherapy, after which changes in the physical and chemical properties of wine materials were observed. The main physical and chemical parameters of the wine material and the ice fraction are determined, which are shown in table 4.

Table 4

Physical and chemical parameters of table wine materials after cryoprocessing.

№	Freezing time, hours	Volume fraction of ethyl alcohol, h%		Mass concentration of titrating acids, g/dm^3	
		Wine material	ice	Wine material	ice
Bayanshira before cryotherapy					
1.	Before processing	11,9	-	6,1	-
After cryoprocessing					
2.	24	11,9	4,2	6,3	1,3
	48	14,9	11,6	5,5	5,3
	96	18,1	5,9	8,1	4,2
Saperavi before cryotherapy					
3.	Before processing	13,9	-	5,4	-
	After cryoprocessing				
4.	24	14,7	1,8	5,6	0,7
5.	144	19,8	5,8	6,5	2,9

As can be seen from Table 4, the proportion of ethyl alcohol in the wine material and ice in the first days of cryogenic treatment did not change significantly. This is due to a gradual decrease in temperature and the formation of the first crystals (latent or induction cycle). Subsequent cryogenic exposure and freezing resulted in an increase in the volume of alcohol in both white and red wine materials and a slight decrease in the ice fraction. It was found that (table 5) polyphenols of all wine materials were identified in the ice fraction during cryoprocessing. However, no significant correlation was observed. Riesling is characterized by an increase in the concentration of phenolic compounds in the ice, while Bayanshira is characterized by a decrease. The ice fraction for Saperavi wine is characterized by a high content of polyphenols.

As the duration of exposure to cold increased, a steady increase in the concentration of polyphenols was observed in all the studied wine materials due to the removal of a certain amount of water. The amount of polyphenols in the ice fraction also increased.

Table 5

Mass concentration of extract components in wine materials and ice fractions after cryoprocessing.

№	Wine material	The processing time, hour.	Phenolic compounds, mg/dm^3		The above extract, g/dm^3		Glycerin, g/dm^3	
			Wine material	ice	Wine material	ice	Wine material	ice
1	Bayanshira	initially	182,0	-	19,1	-	5,1	-
		48	330,5	320,4	24,4	1,8	5,8	0,9
		96	446,4	205,3	28,3	1,66	8,3	0,8
2	Rislinq	initially	216,3	-	18,9	-	4,4	-
		48	366,8	131,8	21,5	2,3	4,8	0,8
		96	390,6	163,4	24,9	2,2	5,7	0,6
3	Saperavi	initially	2316,1	-	24,1	-	7,0	-
		144	3018,3	932,5	38,2	2,8	14,2	0,66

The mass concentration of imported extracts in the wine material was 14.1 g/dm^3 in Saperavi , 9.2 g/dm^3 in Bayanshira and 3.4 g/dm^3 in Risling compared to the preliminary (initial) concentration. Most of the ingredients of the extract were part of the Saperavi wine material.

It was found that the cryoprocessing of wine materials leads to a significant decrease in the concentration of microorganisms in them. In the wine materials after the process, only 10 % of the cells remained, most of which were destroyed or weakened. White and red wine materials after cryopreservation acquired resistance to biological turbidity and were able to maintain stability for more than a year. Based on the results of studies of cryoprocessed table wines, the following improved technology scheme was determined, based on the use of cold acid table wines (figure 3): grape processing, fermentation of white grape juice and crushed red grape varieties. it is performed as in table wine materials.

Freezing of white wine material is carried out at-10-12^{0}C. The temperature for the red wine material is set at minus 14^{0}C. Storage of the processed wine material at a temperature of minus 8^{0}C is set for 3-4 days for whites and 4-5 days for reds. After the end of processing and storage, the wine material is filtered, fed into bottles for bottling and subsequent storage. Considerable research work is devoted to the development of the assemblage and blend of champagne wine materials. There are still different opinions about the processing of these types of wines. According to the idea, confirmed by numerous experiments, processing of raw wine champagne during assembly required with a view to its demetallization and purification of substances that promote oxidation of the wine. To ensure stability, this operation must be performed at the blending stage.

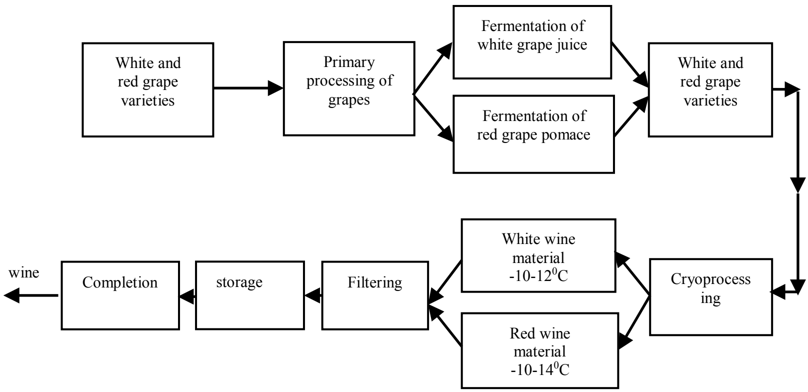

Figure 3. Technological scheme of preparation of table wines with the use of cryoprocessing.

It can be assumed that, although experimental or control blends for champagne do not differ much in composition and properties, they can undergo significant changes when they are served with cryoconcentrate or liqueur. In turn, these changes can disrupt the stability of the filling of the curd mixture (turaj).

However, the stability of the blend used in the liquor production and the high degree of sucrose purification ensure the stability (fermentation) of the blend mixture (this can be illustrated as a control paradigm). When checking the resistance of the blended mixture, filled with cryoconcentration was observed instability. This intolerance was mainly manifested by the turbidity of the protein (experiment).

Compared with the liqueur, the content of phenolic compounds in cryoconcentration approximately two times more. This can create excessive fullness depending on the brand of champagne when the blend is being prepared. In this regard, it was decided that before preparing the blend mixture, the experimental blend of champagne wine materials should be mixed with the treated cryoconcentrate.

The treatment was carried out with bentonite and gelatin. The dose was determined on the basis of a test glue after 7 days of rinsing at a temperature of 2^0C in the refrigerator. After the processing and washing process, the mixture (experiment) was separated from the glue through a filter and placed for 10 days in conditions with an ambient temperature of 13^0C, after which it was subjected to circulation. The processing scheme is shown in figure 4. The test of the prepared mixture according to the available tests showed its resistance to all turbidity.

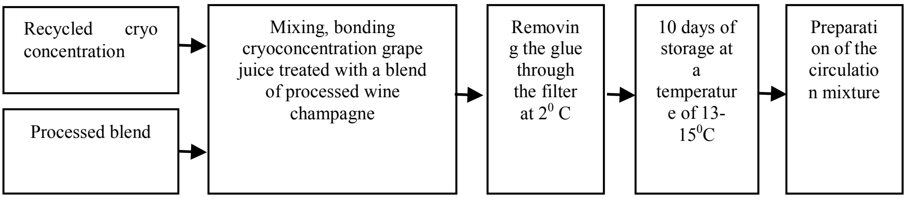

Figure 4. Technological scheme of using cryoconcentrate in blending wine materials.

Whether for practice or control, the circulation and fermentation mixture is designed for the sour champagne product (brut). An experimental model of a suspension of a mixture made from a blend of processed experienced and processed cryoconcentration blend in addition, in the experimental slurry-fermentation mixture were included pure yeast solution (quantitative calculation in 1 cm^3 of a mixture), cooked in a blend of champagne, wine and mixed cryoconcentration, and bentonite slurry mass concentration of 200 g/dm^3.

Based on these estimates, we can conclude that the process of second ferment change the main qualitative indicators of the mixture ferments and sourdough in practice and in control occurred with the same frequency, a significant difference in the results of the analysis were not observed.

The production of higher quality products based on improved technology should simultaneously ensure the profitability of production by reducing costs. In this regard, to determine the economic efficiency of a new technological process, the difference between the replaced technology and the reduced costs incurred with the new technology is determined on the basis of the existing methodology. The report found that as a result of the improvement of the technology of wine production with the use of cryotherapy, the annual efficiency of the volume of production of 1000 bottles amounted to 6913.63 manat.

Results

1. The analysis of the scientific literature shows that the technology of cryogatization is not sufficiently studied in winemaking, the potential for the application and improvement of this technology, which can serve to produce high-quality table and other types of wine, remains insufficiently used.
2. Based on the theoretical analysis of the cryogenization process, it can be concluded that when processing juice or wine material from a vat at freezing temperature, due to the uneven distribution of temperature in the medium, ice pieces are distributed unevenly, which leads to a significant lengthening of the process and an increase in energy costs and working time.
3. It was found that -5...-8^{0}C wine, processed, can be stored significantly in up to-2^{0}C. From the point of view of quality and energy consumption, it is more appropriate to store wine in stages in containers, freezing them in thin layers. For the wines that will be subjected to cold processing, the following requirements have been defined:
   - fast, intense freezing;
   - ensuring comprehensive freezing;
   - make the same effect of the cooling temperature (freezing) everywhere.
4. Based on theoretical considerations, a new experimental crystallizer (cryogenic plant) for grape juice and wine material was developed, which is included in the technological scheme for the preparation of a cryogenic solution for white and red wine materials, champagne.

5. It is experimentally established that when working with step cold, as the number of steps in the cryoconcentrate increases, the level of sugar increase decreases, and when working with ice, it increases. After the second stage, the amount of ice decreases, and the amount of sugars in it increases.

6. When comparing the technological parameters of freezing, it can be seen that the most noticeable parameter of the process is the freezing time. The most rational time of this mud in the layered-step freezing is in the range of 0.5-1.5 hours. In order for the juice from the vat to reach a temperature of minus 2^0C, it is required that the temperature of the cooling agent in the jackets be minus 13-14^0C, for the first and second phases 9 hours and for the third phase 6 hours.

7. It was found that as a result of the cryoeffect on white and red wine materials, the volume fraction of ethyl alcohol in them increases by 1.5-1.9 times, phenol and extractives-by 1.3-1.6 times, the concentration of tartaric and malic acids and potassium cations decreases.

8. As a result of cryotherapy of wine materials of table wines, the concentrations of aroma-forming volatile mixtures change, the total concentration of grain alcohols, aldehydes, esters, ethyl alcohol reaches the maximum value.

9. It was found that when freezing grape juice, the density, viscosity and acidity of the cryo-concentrate increase by 2-4 times compared to the traditional technology for making liqueurs for champagne wines.

10. In champagne made on the basis of cryoconcentrate, the mass concentration of phenolic substances, including those with antioxidant and bactericidal properties, was 14-40 % higher, biologically active substances-2.5 times, titrated acids-25-40 % and foaming capacity-28 %.

11. As a result of the improvement of the technology of wine production with the use of cryotherapy, the annual efficiency of the volume of production of 1000 bottles amounted to 6913.63 manat.

Recommendatıons for producers

- The use of advanced cryoeffect technology and its hardware in wineries to produce high-quality table wines and other types of wine;
- Use of reasonable technological parameters that ensure high quality and economic effect in the production of cryogenic circulation for juices, wine materials and champagne wines.

The main provisions of the dissertation are reflected in the following published articles:

1. Kafarova E.R. Mammadov B.A. History of production of port wine type. / Materials of the XIV Republican Scientific Conference of Undergraduates. Part I, Sumgait, 2014, pp. 341-342.
2. Fataliev F.K. Mammadov B.A. Obtaining juices and wines using low temperatures / Modern agrarian science: actual problems of the century and prospects for development in the context of globalization-International scientific and practical conference. Volume I, 2014, pp. 387-388.
3. Mammadov B.A. Fataliev F.K. Investigation of the influence of cryonation on the quality of juices and wines / / Azerbaijan Agrarian Science, No. 1, 2015, pp. 101-104.
4. Mammadov B.A., Fataliyev H. K. a study of the fermentation of grape must in the stream. // Winemaking and viticulture, M.. No. 5, 2017, pp. 8-11.
5. Mammadov B.A. Device for processing wine material by cryotherapy. Utility model U 2019 0056, Center for Patents and Trademarks of the Azerbaijan Republic public legal entity / C.V. Baloglanova, F.K. Fataliyev, R.T. Khalilov.
6. Mammadov B.A. Experimental determination of the term of cold processing of wine // Azerbaijan Agrarian Science, No. 1, 2017, pp. 125-127.
7. Mammadov B.A. Application of wine technology with the use of cryotherapy / actual problems of modern natural science and economic science. GSU, Ganja, International Scientific Conference. 04-05 May 2018, Part I, pp. 368-370.
8. Mammadov B.A. Tagiyev A.T. Investigation of the influence of cryonation on the chemical composition of wine / II Republican

scientific and practical conference on the topic prospects for the development of the food and textile industry in our republic and upcoming tasks. Azerbaijan State University of Economics, April 25, 2018, pp. 88-90.

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13. Heydarov E.E., Mammadov B.A., Fataliyev H.K., Alekberov A.M, Qadimova N.S., İmanova K.F. Substantiation of cryoprocessing regimes of white and red wine materials // Ciencia e Tecnica Vitivinicola, Vol.35, №5, 2020. pp.40-48.

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