

Akaki Tsereteli State University
Faculty of Technological Engineering

Copyrighted manuscript

Varlam Mindeli

**Technology for Producing a Special Wine from
Colored Grape Raw Materials Growing in Imereti**

The Author's Abstract

of the Doctoral Thesis Nominated for Academic Degree
of the Doctor of Food Technologies (0104)

Kutaisi 2018

The given work is executed at the Department of Food Technologies of the Faculty of Technological Engineering at the Akaki Tsereteli State University

Scientific Advisor: **Temur Gvinianidze**, Doctor of Technical Sciences, Professor

Official reviewers: **Guram Papunidze**, Academician of Georgian Academy of Agricultural Sciences, Doctor of Technical Sciences, Professor
Temur Revishvili, Academician of Georgian Academy of Agricultural Sciences, Doctor of Technical Sciences, Professor

Defense of a thesis will be held on July, 2018 at 12.00, at the session of the Dissertation Commission created by Dissertation Council of the Faculty Technological Engineering. Address: Auditorium №1114, Building I, 59Tamar Mepe Street, 4600, Kutaisi.

Dissertation is available in the library of the Akaki Tsereteli State University at the address: 59Tamar Mepe Street, 4600, Kutaisi

The Author's Abstract had been sent out on June, 2018

Dissertation Council
Secretary, Professor

Nino Dolidze

General description of paper

Topicality of research:

Natural and special wines form the great part of the export potential of Georgia. The fact that according to figures on exports of wine and alcoholic beverages only for the first nine months of 2017, Georgia exported 52.7 million bottles (0,75 l) of wine. According to the National Wine Agency, wine exports have grown up on 63% in comparison with corresponding period last year.

It is known that 30-40% of the trade balance of our country is accounted for grape wines, fruits and mineral waters. Therefore, it is very important to develop such innovative technologies of natural and special wines, the introduction of which will contribute not only to increasing the range of therapeutic beverages, but also also, along with color grape industrial varieties, to maximizing the application of less marketable local raw materials, improving the economic state of people engaged in viticulture, their employment at the place of their residence and significant reduction the rate of rural migration to urban areas. Moreover, most of the rural population in Georgia is engaged in viticulture.

Due to increasing environmental radionuclide background, the scientists and specialists constantly face the problem of developing technologies for producing plant-based, therapeutic-purpose foods and food supplements enriched with biologically active substances, which are characterized by high immunomodulating, radioprotective and antioxidant activity. From such therapeutic-purpose foods and food supplements, of particular importance are the beverages because their improved composition, sensory and liquid consistency provide high availability and increased therapeutic capacity.

It is also noteworthy that since the 80s of the last century, poor-quality and expensive sprays and brought to our country have caused significant damage to the indigenous and alien grape varieties. Georgian farmers were forced to switch partly to growing of nontreated and hybrid grape varieties, because they do not require expensive and imported from outside sprays, and besides, hybrids and clones are easy to grow, and different types of fungi and other diseases are no big deal for them. Today, wineries cannot apply even industrial varieties of colored grapes such as Aladasturi, Dzelshavi, Mgaloblishvili and Black Pinoa.

In view of the foregoing, it reasonable and relevant to develop the innovative technologies for producing natural and special wines from common to western Georgia. Therefore reasonable and relevant to western Georgia-known less marketable local raw materials of colored grape industrial varieties and nontreated grape clones enriched with from biologically active substance enriched with

innovative technology of special wines, which are characterized by high sensor, radioprotective and antioxidant activity therapeutic properties for preventing food-borne diseases.

Goals and objectives of research. The goal of the dissertation work is to develop special wine technology enriched with biologically active substances from the grape raw materials of grape varieties cultivated in the Imereti Viticulture and Winemaking Area, which is characterized by improved sensory indicators and increased therapeutic and preventive capacity. In addition, in this special wine technology, for the first time in Georgia, there will be used raw materials of the nontreated colored Zeibeli grape variety cultivated in the Baghdati Viticulture and Winemaking microzone, rosehip and grape-seed alcohol-wine extracts and small quantity of white honey for the purpose of increasing the flowers tonality.

To implement this goal, the following **objectives should be attained**:

- To study the mechanical composition of selected raw materials;
- To provide uvological evaluation of raw materials;
- To study the chemical composition and sensory characteristics of raw materials;
- To justify theoretically and experimentally the optimal composition of grapes raw material required for special wine
- To develop rational technology of colored grape raw materials processing, alcoholic fermentation and ageing;
- To study the influence of thermal conditioning regimes of the seeds and skins on the extraction of phenolic and dye compounds;
- To develop the optimal technological regimes and approaches for the production of ingredients required for special wine: semi-fermented wine, condensed grape vacuum-must, and grape-seed and dog-rose extracts;
- To provide quantitative and qualitative evaluation of biologically active substances of special wine;
- To develop technological schemes for producing ingredients of special wine;;
- To develop technological schemes for special wine production;
- To assess sensory characteristics and antioxidant activity of special wine.

Research novelty of the thesis paper is that there have been:

- evaluated uvological characteristics of raw materials of colored grape varieties cultivated in the Imereti region, such as "Aladasturi", "Otskhanuri Sapere" and "Zeibeli 5455";
- developed theoretical bases and new technological approaches for extracting anthocyanins from the skins;
- developed rational technological approaches to producing the strong

36

antioxidant, polyphenol concentrates (ingredients);

- studied physical, chemical and technological characteristics of special-wine material in the main fermentation and ageing process, and dynamic processes of their variability;
- developed the quality regulating characteristics of a special wine;
- determined a high sensory effect and strong antioxidant activity of a special wine

Practical bearing of research is that there have been:

- developed and implemented original technology for producing wine-alcoholic hydrophilic extracts and concentrates from colored grape-seeds and dog-rose enriched with biologically active components;
- selected optimal parameters of technological processes for each object by considering chemical composition of colored grape raw materials;
- developed the technological scheme for producing high sensory flowers and special wine with strong antioxidant activity, which envisages obtaining colored grape raw material cultivated in the region, processing in accordance with technology we proposed, and conditioning and ageing of target wine materials with white honey, vacuum-must, grape-seed and dog-rose wine-alcoholic extracts;
- developed technological instruction of producing a special wine enriched with biologically active substances;
- demonstrated through the sensory and laboratory studies that therapeutic-purpose red special wine is intended for environmentally safe food products with high sensory bunch and non-toxic taste.

The following provisions have been brought to defense:

- Justification the use of raw materials of colored grape varieties "Aladasturi", "Otskhanuri Sapere" and "Zeibeli" for producing special wines, as well as the results of uvological and chemical evaluation.
- Influence of the extracts and concentrates wild-growing dog-rose and "Ziebel 5455" variety on the quality characteristics and aging process of target product, as well as the results of their technological studies.
- Study of the total amount of phenolic compounds, anthocyanins and antioxidant activity in grape raw materials and extracts, as well the results obtained.
- Innovative technological approaches and their impact on sensory flowers and antioxidant activity of finished product.
- Finished product technology, and the results of organoleptic and chemical studies.

37

Approbation. The main results of the research were presented at the sessions of the Department of Food Technologies at Akaki Tsereteli State University (2015-2018). The results of the research were reviewed and published in the following conference proceedings:

- International Scientific and Practical Internet Conference "Innovations in Agrarian Sciences". Shota Rustaveli National Science Foundation. Conference Proceedings. Kutaisi. 2016.
- Sixth International Scientific Practical Internet Conference: "Bio-Safe Food Problems and Business Environment". Conference Proceedings. Kutaisi. 2016.
- International Scientific Conference. Georgian Academy of Agricultural Sciences. Conference Proceedings. 2016.
- Materials of the 5. international scientific-practical conference "Innovations: perspectives, challenges, results" /Ed. By prof. dr. Vladimir Grinev. West-Ost-Publishing House Berlin, (Germany)2017.
- III International scientific-practical conference "Modern science: problems and prospects", LOGOS, Stavropol, 2017.
- International scientific-practical conference at Plekhanov Russian University of Economics. Faculty of the hotel, restaurant, tourism and sport industry. Educational and Research Center "Trade". Chair of restaurant business. /Ed. By prof. dr. Vladimir Grinev. West-Ost-Publishing House Berlin, (Germany) 2017.

Publications.

Six scientific articles have been published on the topic of dissertation in peer-reviewed periodicals, including journals included in Elsevier and Erih plus.

Volume and Structure of Dissertation.

Dissertation includes Introduction, experimental part, conclusions and list of references comprising 162 sources and 6 Annexes. The proposed work comprises 129 printing pages, 31 tables, and 34 figures.

Brief content of dissertation

Dissertation includes Introduction, four chapters, general conclusions and list of references.

Introduction formulates topicality of research, defines goal and objectives, novelty of research and its practical bearing

Chapter I (Literature survey) refers to the following issues: description of the viticulture and winemaking zone of Imereti region; industrial colored grape varieties cultivated in Imereti; traditions of producing special wines from colored

38

grape raw materials in Imereti and analysis of demands for them, the influence of the chemical composition of the grape on the quality of wine; grape and wine phenolic compounds; grapes and wine anthocyanins; modern technologies of special wines existing in European wine producing countries.

The second chapter provides description of subjects and methods of research.

The research subject is represented by: raw materials of "Otskhanuri Sapere" grape variety from the Imereti Viticulture-Winemaking subzone, particularly from the Zestafoni district's village of Sviri and the Bagdati district's village of Obcha; raw materials of "Aladasturi" grape variety from the Middle and Lower Imereti Viticulture-Winemaking subzone, particularly from the Bagdati district's village of Rokhi and the Vani district's villages of Pereti and Kumuri, from the Patele Area's vineyards; raw materials of "Zeibeli 5455" ("Zeimberi") grape variety from the Lipnari vineyards; vacuum-must; grape-seed extract; wild-growing dog-rose from the Zekari and Sairme valleys and extracts and concentrates obtained from their skins and fleshes; lime-tree flower honey from the Zekari and Sairme valleys; rectified ethyl alcohol.

Research Methods: when determining the physical-chemical indicators of grape raw materials, wine materials and finished special wine, we used the standard, universally accepted and modified organoleptic and physical-chemical methods, including chromatato-mass-spectrometry, high-performance liquid and gas chromatographies, spectrophotometry and fluorometry

Study of physical and physico-chemical characteristics of grape raw materials, must, wine materials and extracts was carried out in compliance with the rules and methods adopted in response to the requirements of the international standards (ISO-International Organization for Standardization) and state (GOST) standards, in particular: analysis of the mechanical composition of the bunch of grapes was carried out by method of Professor Prostoserodov; specific weight of must, extracts, wine materials and finished products was determined by the method of weighing and determining the volume, according to state standard GOST 14136-75; the sugar content in the grape must was determined by refractometric and densimetric methods, according to state standard GOST 27198-87; the mass concentration of titrated acidity was determined according to state standard GOST 51621-2000; the sugar content in wine in wine materials was determined according to state standard GOST 13192-73 (Bertrand Method); the reduced extract content was determined by weighted-pycnometric method according to state standard GOST 51620-2000; the contents of ethyl-alcohol content (by distillation method)

39

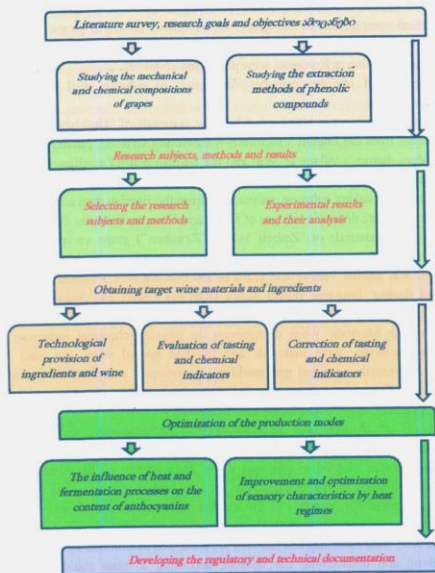


Fig. 1. Structural scheme of milestones relating to research

according to state standard GOST 51653-2000; the content of soluble dry substances was determined by refractometric method, according to state standard GOST 51433-99; the mass concentrations of volatile acids (by method of distillation) was determined according to state standard GOST 51654-2000; the content of free and total SO₂ was determined according to state standard GOST 14351-73; the ash mass concentrations was determined according to state standard

GOST 53954-2010; C vitamin content was determined according to state standard GOST 24556-89; the total amount of extract g/100 cm³ was determined by dehydration method; the total amount of phenols was determined using Folin-Ciocalteu reagent by spectrophotometric method; anthocyanins were determined by high pressure liquid chromatography; the content of monomeric anthocyanins was determined by pH-differentiated method; the total number of flavonoids was determined using AClC3 reagent by spectral method; antioxidant activity was determined by DPPH method; Analysis of sensory or organoleptic indicators was carried out according to state standard GOST 32051-2013.

Of the above listed methods, the most important was method of sensory or organoleptic evaluation of finished products.

The third chapter dwells on the results of studying the objects taken for the experiment, intermediate and finished products, their producing technology and the assessment of quality indicators.

At the initial stage we studied and evaluated the mechanical, physical, chemical and sensory characteristics of the selected grape raw materials.

The grapes is the main raw material for wine production, and we have identified the mechanical composition of the bunch in compliance with the requirements suggested by Prostoserdov.

Table 1 shows the mechanical composition of selected red grape raw materials cultivated in the Bagdati and Vani Viticulture and Winemaking micro-zones in 2016 and 2017 in Bagdati and Vani viticulture and winemaking micro-cultures and the mechanical composition of red grape raw materials by the average data of two years. Tests were conducted during the period from 05. IX to 10. IX.

Table 1

Mechanical composition (data of September 2016-17)

Grape variety	Nth-yea average indicator	Average weight of a bunch of grapes, g	Weight of 100 grapelets, g	Weight of 100 grape-stones, g	Mechanical composition of a bunch of grapes				
					Stalk, %	Skins, %	Grape-stone, %	Flesh with juice, %	
Aladasturi from Lipnari	2	193	216	4,3	2,4	13,7	3,8	80,1	
Zeimbri	2	83	124	3,5	3,4	14,5	3,6	78,5	
Otkhanuri Sapere	2	86	128	3,9	2,2	15,5	3,0	79,3	

Table 2
The variation of the structure of the bunch of the "Aladasturi" grape variety by the date

Bunch indicators	18.08.17	27.08.17	18.09.17	27.09.17	18.10.17	27.10.17
Bunch weight, g	170	176	181	187	192	197
Weight of 100 grapelets, g	178	185	191	198	216	221
Stalk, %	2,44	2,31	2,21	2,19	2,18	2,19
Skins, %	13,67	13,59	13,54	13,50	13,51	13,52
Skins, %	4,45	4,36	4,28	3,88	3,80	3,88
Grape-stone, %	79,44	79,74	79,97	80,43	80,43	80,41
Flesh with juice, %						

Table 2 shows the variation of the structure of the bunch of the "Aladasturi" grape variety by the date.

Table 3 contains the uvological characteristics of grape varieties selected for special wine by October 12-16, 2016.

Table 3
The uvological characteristics of grape varieties from Imereti (October, 2016)

A bunch of grapes	Separate parts of a bunch and their compositions	Grape varieties		
		Otkhanuri	Zeibeli	Aladasturi
	Stalk	3,67	3,27	4,21
	Grapelet skins	8,63	9,55	9,87
	Grape seed	3,23	3,67	3,97
	Juice and flesh	82,98	83,98	81,58
	Skeleton (stalk and skins)	12,29	12,65	14,08
	Solid waste	15,53	19,22	18,05
	Grapelet-content	94,6	109,0	93,17
	Structural indicator	5,48	4,37	4,52
	Dates of sampling	30.10.2016	03.10.2016	30.10.2016

We have carried out studies and evaluation of the chemical composition and variety flavor of selected grape raw materials (Table 4).

Studies show that the value of sugar-acid ratio affects numerous characteristics of wine, in particular the higher is this ratio, the better is the quality of special wine.

Table 4
Physical-chemical characteristics of the selected grape raw materials

Grape variety	The yield of must (juice), %	Mass content of dry substances, %	Mass concentration of sugars g/100cm ³	Mass concentration of titrating acids g/100 cm ³	Active acidity, pH	Sugar-acid ratio
Otkhanuri Sapere from Obchi	72,5	22,9	22,3	0,74	3,4	30,14
Zeibeli from Rokhi	70,4	23,9	23,7	0,68	3,7	34,85
Aladasturi from Lipnari	71,1	22,7	22,2	0,64	3,7	34,68

Figure 2 shows the relationship between phenolic compounds and the sensory indicators in raw materials.



Fig. 2. The relationship between the contents of phenols and anthocyanins in raw materials

Studies show that despite the fact that most of the environmental clean raw materials of Zeibeli grape variety contains the largest amount of total phenols and anthocyanins.

When pressing in a grape stalk separator, the enzyme preparations and dry

active yeasts were added to grape raw materials raw materials, and in parallel, we provided sulphiting of the obtained must or potassium treatment with pero-sulphite for the purpose of maximum extraction of phenolic complex and improving the variety flavor.

We have developed technologies of separate components of special wine and evaluated the quality characteristics by the technological schemes listed below (Fig.3; Fig. 4; Fig. 5).



Fig. 3. Technological scheme for producing grape-seed extracts and vacuum-condensed concentrates



Fig.4. Technological scheme for obtaining dog-rose extract

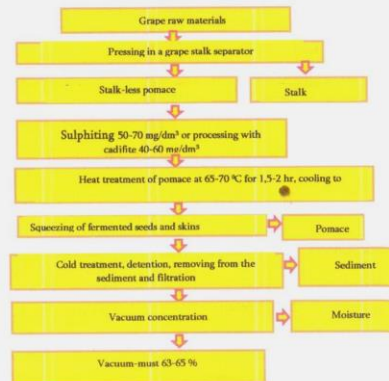
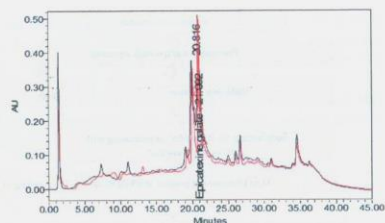


Fig. 5. Technological scheme for obtaining the vacuum-must

The dehydrated grape-stone is subject to heat treatment of the extraction at the temperatures of 105-115 °C for 120-180 minutes. Then, in an extraction vessel, we carry out the extraction of the crushed grape-stone at the temperatures of 45-54 °C temperature with a 70-72% alcohol water mixture. The Hydro Module Ratio grape-seed: extracting agent is 1: 2,5. The duration of the process is 72-80 hours under conditions of the periodic mixing.

Table 5 presents the physical and chemical characteristics of the grape-seed liquid ethanol extracts and concentrates obtained by sublimation dehydration. Figure 6 illustrates the chromatogram of the liquid extract's flavonoids.



SampleName	Acq Method Set	Injection Volume	Channel Description	ColumnT ype
Grape-seed extract 2	Flavonoid 280360 06 40	10.00	W2489 ChA 280nm	C 18

Fig. 6. Chromatogram of ethanol extract of Otskhanuri Sapere grape variety

Some characteristics of liquid and syrup-like grape-seed extract

N	Grapseed extract characteristics	1 test	2 test	3 test	4 test
1	Ethyl alcohol concentration, %	43-45	52-54	61-63	70-72
2	Extraction temperature, °C	45-54	45-54	45-54	45-54
3	Extraction duration, hr.	72-80	72-80	72-80	72-80
4	The volume of liquid extract, ml	250	250	250	250
5	The weight of sublimation extract, % (syrup)	4,74	4,50	4,12	3,58
6	Total phenol concentration, mg/ml	3,38	3,42	3,60	3,72
7	Concentration of anthocyanins, mg/ml	0,93	1,24	1,33	0,99

Figure 7 illustrates a profilogram of antioxidant activity of liquid grape-seed extracts

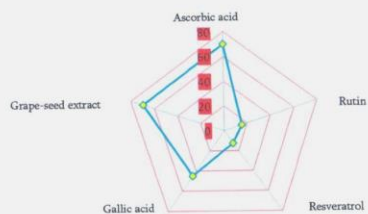


Fig. 7 – A profilogram of the percentage inhibition of free radical (DPPH) activity by grape-seed extract

The dog-rose extract obtained on a dog-rose by adding a 18-70% ethylene, contains a relatively small amount of biologically active substances in comparison with a dog-rose micro-powder and dog-rose itself, so we had therefore considered it appropriate to use, after blending, the crushed dog-rose fruit in the process of ageing, which has not more than 6-7 % moisture content, and therefore not only ascorbic acid and other biologically active substances are transferred into wine.

Vacuum-must is an essential component of special wine-making technology not only for adjusting the sugar and alcohol contents in the seeds and skins and wine materials, but also research investigations have revealed that high sugar content in the fermentation process also conditions the high-taste properties of special wine to be made.



Fig. 8. Vacuum-sublimation drier



Fig.9. "Subligram"

It is known that in special wines, the higher the amount of naturally obtained alcohol and the lesser it supplied by extracts and concentrates from the outside, the more precious and the better target product. Moreover, dry active yeasts are capable of not stopping the activity even when the content of alcohol in wine material is up to 14% by volume, which is quite acceptable for our experiment because we are interested in the alcohol content in the test wine material within 14-16% by volume. Therefore, of high relevance is to use the condensed vacuum-must in the production of liqueur wines.

We have obtained a vacuum-juice "Zeibeli" grape variety using a rotary vacuum-evaporator (Chinese rotary evaporator RE 501) vacuum-evaporator (see Annex) and Chinese sublimation vacuum-drier (Fig. 8). Figure 9 illustrates a "subligrum" characterizing the vacuum-sublimation process, which simultaneously shows the graphs of time, temperature and vacuum changes. In the laboratory, we have obtained the vacuum-must on a rotary evaporator and through sublimation drying using a Chinese sublimation vacuum-drier (Chinese sublimation drier manufactured by SJA LAB company). The vacuum-must obtained through sublimation drying had the better physical, chemical and sensory indicators.

Development of special winemaking technology and the proposed innovations. Along with the selection of high quality raw materials in the production of red special wines, the fermenting and fermentation processes have the main function in the formation of a sensory bunch.

The list of the proposed innovations is as follows:

- Adding of pectolytic (with activity 2000-2200 unit/g) enzyme (Rapidase CR) to the seeds and skins during the process of pressing in a grape stalk separator, increases the yield of the must by 5-7% and the content of biologically active substances for 1-2 ml/100 kg.
- Adding of potassium metabisulfite within 54-63 mg/dm³ significantly increases extraction of anthocyanins, increases to 1.2 - 4.3 g/dm³ – the reduced extract and the content of dyes, contributes to purification, the growth in terpenic compounds by 2,1-2,7%, and the growth in a stable fraction of a phenolic complex (within 20-25%) in wine.
- We added 1-2% of *Aspergillus* fungus of the dry active yeast in a grape stalk separator (C-R-9001 or C-RB-9001- fungus works at the temperature of 12 - 28 °C, pH=3,0-5,4 and increases alcohol content up to 24%, and significantly increases the content of terpens and esters in wine).
- Adding of the condensed concentrate with the content of dry substances up to 54-63 % through the dog-rose liophilic drying to the seeds and skins within 50-75 mg/dm³, in the presence of or cadifite (40-70 mg/dm³) either SO₂ (90±10

mg/dm³) increases by 1.5-1.8 the development of variety flavor in a special wine.

- During the fermentation of the seeds and skins, we raised the sugar content up to 27% by adding the vacuum-must and honey, due to which terpenic compounds were increased by 0.7-1.2 %, and esters by 24-27%.
- We have established that after the 6-day extraction-fermentation at a temperature of 27°C, the seeds and skins are subject to heat treatment at a temperature of 54 °C, and hot pressing, which significantly increases separation of phenolic and dye compounds.
- Adding of the grape-seed and dog-rose concentrates and heat-treated grape-seed (5 g/dal) and oak shavings (5 g/dal) significantly improves the rancio tones and sensory bunch.
- In 16 - 18 months, adding of dry dog-rose pulp and peel (20 g/dal) increases the flavor-forming complexes.
- Adding of the grape-seed and dog-rose concentrates and heat-treated grape-seed during the ageing process, under conditions of periodic pasteurization and stirring within 2-3 months, increases the total amount of phenols by 0.3 - 0.4 g/dm³, and improves the rancio tones and sensory bunch.
- Prohibition of using gelatin and bentonite clays, because for processing wine materials, bentonite clays reduced the anthocyanins by 27-36% on 2-3 kg/t, while the use of gelatin reduced the compounds of phenolic compounds by 6-9% on 2 - 3 g/t.
- Creating a new technology by using new varieties and honey flower tones.



Fig. 10. The influence of the temperature of fermentation on the extraction of anthocyanins

We have studied the impact of the temperature of the fermentation of the seeds and skins (see Fig. 10) on the extraction process of anthocyanins from the skins in the fermenting mass. Studies were carried out at four temperature intervals 34-36 °C, 27-30 °C, 21-25 °C and 16-18 °C.

Table 6

Physical and chemical characteristics of pomace fermentation		
N	Fermentation temperature	The density of the fermented mass during the maximum concentration of anthocyanins
1	16-18 °C	1,033-1,035
2	21-25 °C	1,042-1,045
3	27-30 °C	1,051-1,055
4	34-36 °C	1,060-1,062

Table 6 shows the main fermentation temperature, the duration of maximum extraction of anthocyanins and the density of the fermented mass.

Figure 11 shows that the total number of phenols increases in the fermented must together with the alcohol content, since the density decreases and polarity of the fermented mass as the extracting agent, increases.

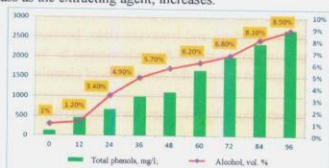
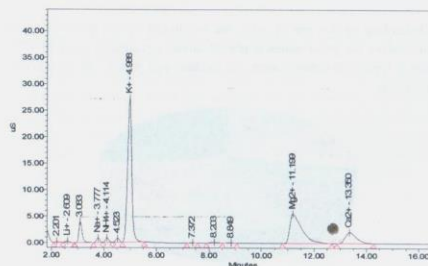


Fig. 11 The relationship between the increase in the alcohol content and the content of total phenols



Fig. 12. A "subligram" of the grape-seed extract concentration



SampleName	Date Acquired	Acq Method	Channel	Channel Description	Column Type	
wine	19-Jul-16	Catione	eSATIN-Ch1	Conductivity	IC-Pak Catione	
quLaisiX10	18-51-10 GET	EDTA				
Name	Retention Time	Area	% Area	Amount	Units	Peak Type
	2.201	41303	0.34			Unknown
Li+	2.609	63838	0.52	11.577	ppm	Found
	3.083	663979	5.46			Unknown
Na+	3.777	155313	1.28	1.375	ppm	Found
NH4+	4.114	167430	1.38	0.855	ppm	Found
	4.523	148472	1.22			Unknown
K+	4.988	6091204	50.05	72.012	ppm	Found
	7.372	8882	0.07			Unknown
	8.203	45197	0.37			Unknown
	8.849	17007	0.14			Unknown
Mg2+	11.199	3529415	29.00	12.250	ppm	Found
Ca2+	13.350	1238049	10.17	7.997	ppm	Found
Sr2+	14.906					Missing
Ba2+	18.739					Missing

Fig.13. The chromatogram of the cation complex in a special wine

In the process of ageing, we regularly analyze phenolic compounds, the total number of flavonoids, anthocyanins, antioxidant characteristics of cations and anions, and most importantly, the analysis of taste or sensory characteristics.

Figure 13 illustrates a chromatographic analysis of cations in a 12-month aged special wine.

Depending on the age of wine, the maximum of the spectrophotometric adsorption curves for green wines is placed in the wavelength range of 520-530 nm, which is typical of anthocyanins, for medium-age wines - in the wavelength range of 420 nm.

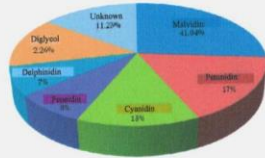


Fig. 14. The percentage ratio of the amount of anthocyanins in a special wine

Special wine "Salkhino", produced by the famous winemaker Valerian Kandelaki was ageing for four years. According to the technology we proposed, ageing is accelerated, that means that it is carried out by heating-cooling method, by adding the thermally-treated oak shavings and grape-seeds, using dog-rose and grapeseed extracts.

Table 7 contains the physical, chemical and sensory characteristics of the special wine after the 18-month ageing.

Special wine characteristics after the 18-month ageing

Characteristic	Value
Ethyl alcohol volume content, %	14,5
Sugars mass concentration, g/dm ³	45-48
Titrating acidity mass concentration, g/dm ³	8,7-8,9
Reduced extract mass concentration, g/dm ³	32,87
Volatile acids mass concentration equivalent to vinegar acid, g/dm ³	0,48
Dye substances, mg.l	749,89
Phenolic compounds, mass concentration, g/dm ³	3420
Including:	
Monomeric forms	2270
Polymeric forms	1150
Tasting evaluation, scores	9,3

The results of studying the physical and chemical indicators of special wine materials are given in Table 8.

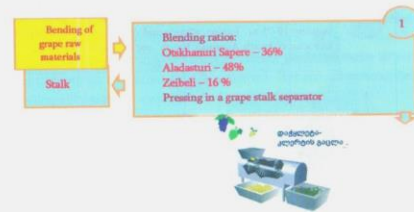
In all five samples, the content of raw materials of Zeibeli grape variety varied between 10-20%, while the amount of raw materials Aladasturi and Otskhanuri Sapere grape varieties - between 20-50%. Aladasturi and Otskhanuri Sapere grape varieties were blended in the proportion 36:48:16 (percentage ratio). As shown from the table, the wine produced has a high sensitivity rate (9,7 cents), which is the result of the composite effects of the selected raw materials of the selected raw materials, the use of ingredients and the technological processes of individual technologies.

Table 8

Wine produced from blended raw materials with various ratios

Wine samples	Specific weight	Alcohol content, %	Content, g/dm ³ in wine					
			Total acidity	Tartaric acid	Volatile acids	Extract	Sugar	Ash
Sample 1 (2016)	0,9946	14,6	5,2	2,5	0,9	28,9	14,9	2,82
Sample 2 (2016)	0,9965	14,4	5,1	2,3	0,9	29,6	17,8	2,96
Sample 3 (2016)	0,9963	14,4	4,9	2,4	10,5	28,9	18,9	2,76
Sample 4 (2016)	0,9947	14,5	5,3	2,5	0,86	30,5	21,5	3,12
Sample 5 (2016)	0,9953	14,5	5,4	2,6	0,85	31,5	24,6	3,45

Development of technological scheme



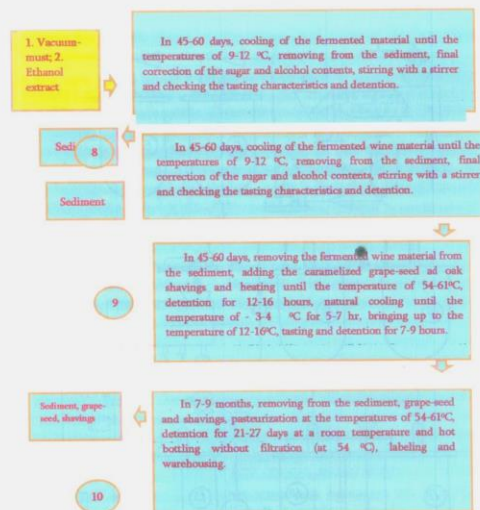
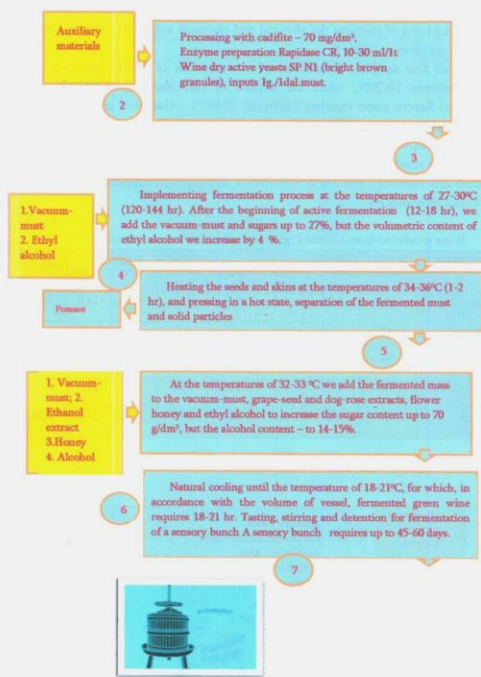


Fig. 9. Principal technological scheme for special wine production

Figure 10 illustrates the development of the hardware setup of innovative technology, in which the technological equipment is disposed in accordance with the technological processes and regimes.

- obtaining grape raw materials;
- grape stalk separator;
- grape stalk receiver;
- seeds and skins collector;
- seeds and skins pump;
- tanks with mixing and heating-cooling systems;
- seeds and skins pump;
- hydraulic press;
- wine pump;
- tanks with mixing and heating-cooling systems;
- wine pump;
- tanks with mixing and heating-cooling systems;
- wine pump;
- pasteurizer;
- tanks with mixing and heating-cooling systems;
- filter;
- bottling line.

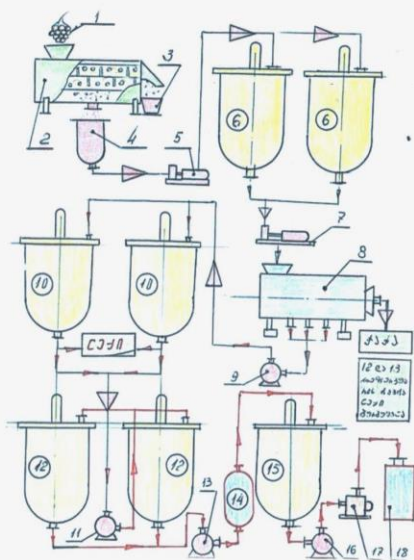


Fig. 10. The hardware setup of a special wine technology

The fourth chapter dwells on the analysis and evaluation of the quality and technical characteristics of a special red wine.

Table 8 shows the analysis of physical and chemical indicators of a special wine we developed.

Table 9

Physical and chemical indicators of a special wine		
N	Indicators	Value
1	Ethyl alcohol volumetric content, %	15±0,5
2	Sugars mass concentration, g/dm ³	30±3
3	Titrating acids content, g/dm ³	7,5±1
4	Volatile acids concentration, g/dm ³	0,9-1,1
5	Reduced extract mass concentration, g/dm ³	18-21
6	Clitric acid mass concentration, g/dm ³	0,7-0,9
7	Cadifite concentration, g/dm ³	40 ± 5
8	Sensory evaluation by a 10-score system	9,7

As shown in the table, the developed wine has a high sensory indicator (9,7 scores), which is the result of the composition of the effects effects of the variety flavor, used ingredients and the individual technological processes of selected raw materials.

Table 10

The content of phenolic compounds in a special wine		
N	Phenolic compounds characteristics	Amount
1	Total phenols, mg/dm ³	3678
2	Monomeric fraction, mg/dm ³	156
3	Anthocyanins, mg/dm ³	411

The economic efficiency or profitability from the introduction of the work, is expected at 200%, and the expected payback period is 6 months.

General conclusions

- It has been experimentally determined that the grape picking should be done when the concentration of the sugar content in the grapes is not less than 23-24g/100 cm³ and titrated acidity is 6-8 g/dm³. And pressing of grapes in a rolling grape stalk separator enriches the seeds and skins with the phenolic complexes of stalk.
- It has been established that colored grape raw materials blended with an optimal ratio of "Aladasturi", "Otskhanuri Sapere" and "Zeibeli 5455" grape varieties is promising for the production of high-quality special red wines with a distinctive

- variety flavor, and rich technological reserves of phenolic (3765-4314 mg/kg) and dye (976-1432 mg/kg) compounds.
- The optimal version of blending for producing a special dessert wine with the best sensory bunch has been determined experimentally: ("Ottisanuri Sapere"); ("Aladasturi"); ("Ziebeli 5455") = (27-36%); (42-54%); (16-18%).
 - It has been investigated that in the process of pressing in a grape stalk separator, in the composition with the enzyme preparation Rapidase CR the kernel gap in the 1-2 mL / 100 kg of enzyme preparation in potassium metabisulphite with 54-63 mg/dm³ and special (dry active yeast) *Aspergillus fungus* 1- 2% Composition (CR-9001 or C-RB-9001-fungus works at temperature of 12-28 °C, pH = 3,0-5,4 and stands alcohol up to 24%), increases the the yield of must, sensory characteristics, the content of extractive (increases the reduced extract up to 1,2- 4,3 g/dm³) and dye substances in wine and contributes to its rapid purification.
 - It has been established that sulphiting of the seeds and skins with potassium metabisulphite with 54-63 mg/dm³, contributes to the emergence of the variety flavor (increase of terpenic compounds by 2,1-2,7%) and the increase in phenolic complex (within 20-25 in wine).
 - There has been determined the relationship between the creation of the flavor-forming complexes and the sugar mass concentration in grapes raw materials, in particular the content of terpenic compounds is increasing by 0,7-1,2%, and the content of esters – by 16-27% when the sugar content in grapes raw materials is 22-27 g/100 cm³, than when sugar content in the grapes is less than 18.6%.
 - It has been studied that through the dog-rose liophilic drying until 54-63%, adding of the condensed concentrate to the seeds and skins within 50-75 mg/dm³, in the presence of or cadifite (40-70 mg/dm³) either SO₂ (90±10 mg/dm³) increases by 1.5-1.8 the development of variety flavor in a special wine
 - It has been experimentally determined that during the aging process of wine material, adding of:
 - dehydrated dog-rose pulp and peel at 20 g/dal,
 - thermally-treated oak crumb at 5 g/dal,
 - thermally-treated grape-seed at 5 g/dal
 under conditions of periodic pasteurization and stirring within 2-3 months, increases the total number of phenols by 0.3-0.4 g/dm³, improves the rancio tones and sensory bunch.
 - It has been established that after completion of ripening (16-18 months), adding of dog-rose condensed extract to wine material within 50-70 mg/dm³, slows

down the phenolic-kinone transformations and increases the flavor-forming complexes.

The main results of the dissertation work are reflected in the following publications:

- Gvinianidze Teona, Mindeli Varlam, Bukhaidze Lasha, Chikovani Papuna, Gvinianidze Temuri. Development of technology for obtaining liquid hydrophilic extract of stinging nettle. Periodical scientific journal "KHANDZTA", No 13(18), 2016, pp. 124-130.
- Teona Gvinianidze, Vakhtang Kvantidze, varlam Mindeli, Temur Gvinianidze. Development of technology for obtaining hydrophilic extract of bilberry. Periodical scientific journal "GONI", No 4, Kutaisi, 2016, pp. 69-74.
- O. Nishnianidze, V. Mindeli, L. Bukhaidze, T. Gvinianidze, Grapeseed extracts of Zeibeli variety and studying their potential use in novel functional foods. Periodical scientific journal "KHANDZTA", No 5(20). Kutaisi-Tbilisi, 2017, pp.5-9.
- T.N.Gvinianidze, T.T.Gvinianidze, P.M.Chikovani, V.A.Mindeli, R.H.Djabnidge – Colored Grapes Byproducts as the Source for Bio-active Products. Scientific Journal "Juvenis scientia" Sank-Peterburg, Russia. N 8, 2017, 8-10 p.
- T.N.Gvinianidze, P.M.Chikovani, T.T.Gvinianidze, R.H.Jabnidge, V.A.Mindeli. Colored grape polyphenol concentrate. Scientific Journal "Annals of Agrarian Science" Tbilisi, Georgia. Volue 15, Issue 4, December 2017, p. 472-475.
- Mindeli Varlam, Chikovani Papuna, Gvinianidze Temuri – Study of the Patterns of Extracting Biologically Active Compounds from Grape-Stone of Otskhanuri Sapere Variety. BULLETIN of Akaki Tsereteli State University. Kutaisi, Georgia. N1(9). 2017. 19-28 p.
- T.Gvinianidze, L. Mamrikishvili, V. Mindeli. The use of wine-alcohol extracts in the technology of liquor wines. International Scientific-Practical Conference "Innovations in agrarian sciences", Shota Rustaveli National Science Foundation. Conference Proceedings. pp. 81-85, Kutaisi, 2016.
- T.Gvinianidze, I. Japaridze, V. Mindeli, L. Bukhaidze, T.Gvinianidze. Anthocyanins of red grape clones. VI International Scientific-Practical Internet Conference on "Problems of Bio-Safe Foods and Business Environment", Kutaisi, 2016.
- Gvinianidze Temur, Mindeli varlam, Gvinianidze Teona. Secondary resources

- of colored grape varieties, as the best sources of highly effective polyphenolic preparations. International Scientific Conference. Georgian Academy of Agricultural Sciences, 2016, Proceedings, pp. 601-604.
10. Bukhaidze L.A., Gvinianidze T.N., Mindeli V.A. Technology for Obtaining CTC Tea Enriched with Peel of Red Grape Clones. Materials of the 5. international scientific-practical conference "Innovations: perspectives, challenges, results" /Ed. By prof. dr. Vladimir Grinev. West-Ost-Publishing House Berlin, (Germany)2017. 318-324 p
 11. Gvinianidze Teona, Chikovani Papuna, Gvinianidze Temuri, Mindeli Varlami – Composition of Hydrophilic Extracts from Therapeutic plants. Сборник материалов III международной научно-практической конференции "Современная наука: Проблемы и перспективы", "Логос", г.Ставрополь. 2017. 152-156 с.
 12. Gvinianidze T.N., Gvinianidze T.T., Mindeli V.A. - Anthocyanins of red grape. Materials of the I. international scientific-practical conference at Plekhanov Russian University of Economics. Faculty of the hotel, restaurant, tourism and sport industry. Educational and Research Center "Trade". Chair of restaurant business. /Ed. By prof. dr. Vladimir Grinev. West-Ost-Publishing House Berlin, (Germany)2017. 288-294 p.