PROCEEDINGS OF THE YEREVAN STATE UNIVERSITY

Chemistry and Biology 2022, **56**(1), p. 18–30

Chemistry

STUDY OF OIL AND POMACE FROM GRAPE SEEDS FOR THE IDENTIFICATION OF PREREQUISITES OF THEIR COMPLEX PROCESSING

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The work is devoted to a comparative study of the physicochemical, organoleptic characteristics of oils obtained by extraction method using sunflower oil and pomace remaining after their processing in order to identify the prerequisites for further use. The study object was the seeds of wine grapes of Khindoghni and Areni (grown in the Republic of Armenia), harvest of 2019–2021.

The purpose of this study was to determine the comparative indicators of the quality and content of fatty acids in grape oils by gas-liquid chromatography. The optimal conditions for obtaining high quality unrefined grape oil for the food and pharmaceutical industries from grape seeds of Khindoghni and Areni varieties by the extraction method were determined: temperature 45–50°C, at atmospheric pressure and carbon dioxide gasbag (CO_2), stirring time 16 *h*. Under these optimal conditions the oil yield was 9.5%. It has been shown that oils from the seeds of Khindoghni and Areni grape varieties contain 1.181 *mg*/100 *g* tocopherols, 3.2 *mg*/100 *g* carotenoids, vitamins C, P, E and the pomace of their processing contains valuable free organic acids: 0.093 *mg*/*mL* oxalic, 3.105 *mg*/*mL* tartaric, 0.48 *mg*/*mL* citric. It has been shown that the content of macro- (Fe, Cu, Zn, Ca, Mg, etc.) and microelements (Mn, Co, Cd, V, Se, Cr, As, Pb, etc.) in the seeds of the studied samples are within permissible limits. On the basis of the research carried out, a scheme for the complex processing of grape raw materials has been developed.

https://doi.org/10.46991/PYSU:B/2022.56.1.030

***Keywords*:** grape seeds, extraction using sunflower oil, grape seed oil, polyunsaturated fatty acids, free organic acids, macro- and microelements.

Introduction. The policy of any modern country in the field of healthy nutrition of the population provides for the improvement of the food structure, one of the directions of which is the enrichment of food products with biologically active substances (BAS) first of all from natural sources. Fruits and berries, as well as

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grapes are important natural sources of biologically active substances, the share of which in the diet of the population of any country is an indicator of the quality of life and the duration of the period of active life.

Grape seed oil has a rather high demand on the world market in food, cosmetic and pharmaceutical industries, since it has a wide spectrum of biological activity [1–4]. Grape oil is characterized by a high content of poly- and monounsaturated fatty acids. It also contains tocopherols (vitamin E), carotenoids (provitamin A), chlorophylls and phenolic compounds, which contribute to an increase in antioxidant, immunostimulating, anti-inflammatory, bactericidal, astringent and wound-healing activity. These compounds cannot be synthesized by either the human or animal organism; they can only be obtained from food [5–9].

Grape oil is obtained from grape seeds contained in pomace of the wine and juice industries. The pomace yield ranges from 20–25% of the mass of processed grapes, and the content of grape seeds in pomace is 25–38% [10–12]. Grape seeds contain 10–20% oil [8, 10] consisting mainly of triglycerides of fatty acids. The place of growth and grape variety, as well as the method of obtaining grape oil, affect the yield, quality of the obtained product and the field of its use [3–8].

Grape oil is isolated from the seeds by two main methods: pressing and extraction. The cold pressing method is rarely used in practice, because of the relatively low yield of the final product, less than 8% [13], although this method allows to preserve in it all biologically active substances that determine its useful properties.

Subcritical CO_2-extraction and supercritical fluid extraction with carbon dioxide (SCFE–CO_2) are modern and promising methods for extracting biologically active substances from plant raw materials [1, 3, 10]. Subcritical CO_2 extraction is slow, cold, clean, undamaged, but with a less deep extraction matrix and limited capabilities for yield targeting and fractionation.

Supercritical CO_2-extraction is fast, hot, dirty, damaged, but with a deeper extraction matrix and a wide range of yield targeting and fractionation. These characteristics quite clearly outline the subject area of applicability of each of the technologies under consideration: subcritical CO_2-extraction is more of a universal tool, supercritical is a specialized one. The transition to a supercritical state (phase transition liquid-fluid) has its own cost, which is expressed in increased pressure and temperature. Both of them negatively affect the integrity of the extracted substances – some of the thermolabile compounds decompose, thereby violating the integrity of the extraction matrix and at the same time contaminating the final product (for example, during supercritical extraction there are frequent cases of sugar caramelization, which gives the extract an almost unavoidable and rather unpleasant smell and taste of burnt sugar). Increased pressure creates a specific environment, in which the substances included in the extract (both native and thermal decomposition products) enter into chemical reactions with each other, the course of which and the effect of their results on the final product is extremely difficult to predict. Particularly, unpleasant is the fact of rancidity of unsaturated fatty acids under conditions of temperature exposure at high pressure, which negatively affects the shelf life of supercritical extracts as many of them quickly develop the smell of rancid oil [14–16].

Taking into account the high cost of these methods, the extraction methods using of selective extractants are still relevant [17].

In the Republic of Armenia more than 160 thousand tons of grapes are annually grown, of which about 130 thousand tons of industrial grapes are used for the production of wines and brandies. The resulting grape pomace (approximately 30–35 thousand tons) is not practically used in the Republic.

The purpose of this work was to obtain oil from the seeds of industrial grape varieties of Khindoghni and Areni by the extraction method using sunflower oil as a selective and non-toxic extractant and to determine the content of fatty acids, carotenoids, various vitamins in grape oil, free organic acids in primary pomace, as well as macro- and microelements in the feedstock.

Experimental Part.

Analysis and Characterization of Raw Materials. The study object was the seeds of industrial grapes of Khindoghni and Areni (wineries of the Republic of Armenia) obtained in 2020. The moisture and ash content of the seeds were determined according to the methods [15]. To destroy the thick skin, grape seeds were ground in a laboratory mill LM-201 (NV-lab, Moscow, Russia) in several stages, each time sifting through a set of sieves 1.00, 0.45 and 0.25, taking a fraction of 0.45–0.25 *mm*.

Obtaining Oils from the Seeds of Khindoghni and Areni Grape Varieties. Oil samples were obtained in a special reactor with an automatic stirrer and temperature control (no more than 45–50°C) and a cooling jacket with running water. For this, a calculated amount of sunflower oil was poured into the reactor and when the temperature in the reactor reached 40°C, 0.25–0.45 *mm* fraction of crushed seeds of Khindoghni or Areni wine grapes was added in portions within 10 *min*. At a carbon dioxide gasbag the mixture was stirred for 16 *h* and filtered using automatic oil filters. The numerical indicators of the grape oil samples were determined according to the methods [16].

The quantitative determination of carotenoids, vitamins C, P, E, the amount of extractives and the moisture content in the fruits of Areni or Khindoghni grapes were defined according to the methods [17–21].

Extraction of Anthocyanins from Grape Fruits. Separated juice from fresh grape fruits of Areni or Khindoghni (1 *kg*) was mixed in a stirrer with 3 *L* of methanol ("Merck", Darmstadt, Germany), acidified with 0.5% trifluoroacetic acid (TFA, "Merck") and filtered first through muslin sheets and then through filter paper No. 4 by suction. The accumulated aqueous-alcoholic extract was evaporated to about 500 *mL* using a rotary evaporator at a temperature not exceeding 40°C. The obtained concentrated aqueous extract was extracted with ethyl acetate (EtOAc, "Merck") (500 *mL*×4) to remove lipophilic material. The aqueous layer (500 *mL*) was divided into two equal portions after evaporation of the remaining EtOAc. Each portion was loaded onto Amberlite XAD-7 ("Sigma-Aldrich", USA) column (18×6.5 cm^2) pretreated with acidified water (0.5% TFA). The columns were washed with acidified water until the color of the elution water faded (approximately 3 *L* of acidified water). The crude anthocyanin mixture was eluted with 1 *L* of acidified methanol and the combined methanol extracts were evaporated and lyophilized to obtain 5.0 *g* of a crude mixture of anthocyanins.

Preparation of Anthocyanin-rich Fraction. Crude extract of blueberry (5.0 *g*) was loaded onto Sephadex LH-20 ("Sigma-Aldrich", USA) column (40×4 cm^2)

packed in acidified water : MeOH = 80 : 20 and anthocyanins were eluted using the same solvent ratio. Four fractions, each approximately 200 *mL*, were accumulated when the colored material began to elute from the column. The fractions were immediately dried out using a rotary evaporator and lyophilized.

Optimal conditions for the extraction of anthocyanins: extractant – 1% solution of hydrochloric acid ("Sigma-Aldrich", USA) in 95% ethyl alcohol ("Sigma-Aldrich"), heating for 30 *min* in a water bath, the ratio of raw material : extractant = 1 : 50.

Method for the Quantitative Determination of the Amount of Anthocyanins in Fresh Fruits of Areni Grape Variety. Quantitative determination was carried out by direct spectrometry (UV-1800PC Spectrophotometer) in an acidic medium at an analytical wavelength of 546 *nm* (Fig. 1).

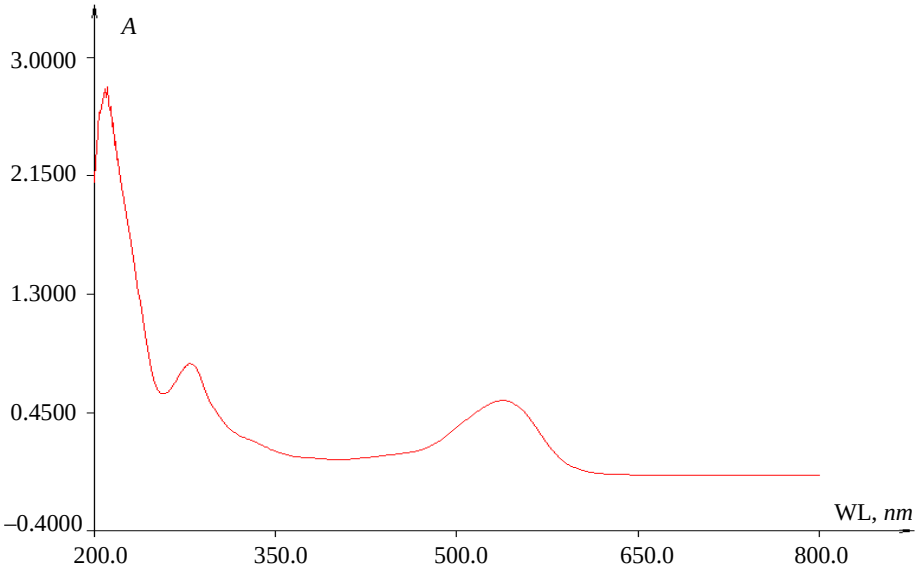


Fig. 1. Electronic absorption spectrum of anthocyanins isolated from fresh juice of Areni grape.

Determination of Flavonoids by HPLC. Analysis was performed by Waters Alliance 2695 HPLC ("Waters corporation", USA) separation module using Nucleosil C18 ("Sigma-Aldrich", USA) column, 4.6×250 mm^2, particle size, 5 μm, injection volume, 10 μL and flow rate, 1.0 *mL*/*min*. A mixture of solvents (methanol : H_2O : acetic acid = 50 : 48 : 2) was used as a mobile phase and was detected at 254 *nm*.

Determination of Organic Acids by HPLC. Free organic acids were quantified using the same HPLC system. Chromatographic separation was achieved on Altima C18 column (4.6×250 mm^2) by isocratic delivery of the mobile phase (water : : methanol : acetonitrile : phosphoric acid ratio = 98.9 *mL* : 0.5 *mL* : 0.5 *mL* : 0.1 *mL*) at flow rate of 0.7 *mL*/*min*. The presence of three free organic acids (tartaric, oxalic and citric) with a predominant content of tartaric acid of 3.105 *mg*/*mL* was determined.

Determination of Fatty Acids by GC. Thermo Scientific TRACE 1300 GC ("Waltham", USA) with a flame ionization detector (FID) was used for GC experiments. To separate the components, Thermo Scientific TR 5MS ("Waltham") column with dimensions of 30 *m*, 0.25 *mm* (internal diameter) and 0.25 *m* (film thickness) was used. N_2 was used as a gas-carrier at a flow rate of 1.2 *mL*/*min* in a

constant flow mode. A volume of 2 μL of the sample was injected in a splitless mode. The injection port was set to 270°C and the temperature of the oven was initially set to 40°C for 1 *min*. The oven temperature was increased to 70°C at the rate of 5°C/*min* for 5 *min*, 140°C at the rate of 5°C/*min* for 5 *min*, 200°C at the rate of 5°C/*min* for 5 *min*, 250°C at the rate of 5°C/*min* for 5 *min* and finally to 270°C at the rate of 5°C/*min* for 5 *min*. The maximum oven temperature was set to 270°C.

Preparation of Oil Samples. For the sample preparation, 10 μL of each oil was dissolved in 1 *mL* methanol/water (4 : 1, v/v) solution, stored at 4°C and used as needed.

Preparation of Standard Solutions. A standard solution for myristic, palmitic, linoleic, oleic, stearic acids and a mixture of tocopherol ("Sigma-Aldrich") was prepared by weighing 10μg of each standard and dissolving them in 50 *mL* methanol/water (4:1, v/v) solution. The solution was then stored at 4°C and used as needed.

Determination of the Elemental Composition of Fruits and Oilcake of Khindoghni and Areni Grape Varieties. The study was carried out by inductively coupled plasma optical emission spectrometry using Agilent 5800 ICP-OES ("Agilent Technologies", USA) with axial and radial view. The sample introduction system consisted of a Sea Spray nebulizer, a single-pass cyclonic spray chamber and a "DV-i.d" injection torch with a diameter of 1.8 *mm*.

For the study, analytical grade reagents and high purity deionized water from the Milli-Q system (resistance > 18.2 MΩ *cm*, "Millipore", USA) were used. Before preparing the solutions, all laboratory materials were sterilized by soaking in 10% HNO_3, then washed with high purity water. Subsequently, all materials were dried out in a drying oven.

All solvents and reagents were of the highest commercially available purity. To dissolve the sample, 69% (v/v) HNO_3 ("Merck") and 30% (v/v) H_2O_2 ("Merck") were used. Agilent high purity monoelement calibration solution (5190–9408, "Agilent technologies") containing 500 *mg*/*L* Ca, K, Mg, Na, 200 *mg*/*L* Al, Ba, 100 *mg*/*L* Fe, 60 *mg*/*L* Sb, 50 *mg*/*L* Co, V, 40 *mg*/*L* Ni, 25 *mg*/*L* Cu, 20 *mg*/*L* Zn, 15 *mg*/*L* Mn, 10 *mg*/*L* Ag, As, Cr, Tl, 5 *mg*/*L* Be, Cd, Se, 3 *mg*/*L* Pb, Sr was used. Pb in 5% nitric acid was also used. To dilute the standard solution, 5% nitric acid was prepared. The argon purity exceeded 99.99%.

Sample Preparation. Approximately 200 *mg* of the samples were added to teflon vessels with 8 *mL* HNO_3 69% (v/v). The mixtures were left at room temperature for about 15 *min*. The microwave heating program was applied as follows: (1) 20 *min* to 180°C, (2) 20 *min* exposure at 180°C. The vessels were then removed from the microwave rotor and cooled to room temperature. After decomposition, deionized water and 2 *mL* of 30% (v/v) H_2O_2 were added to bring the final volume to 50 *mL*. All samples were filtered with BLUE LINE ("Len Reaktives", Russia) filters.

Based on the study of oil and pomace from the seeds of industrial grape varieties of Khindoghni and Areni, reliable prerequisites for their complex processing were revealed (Fig. 2).

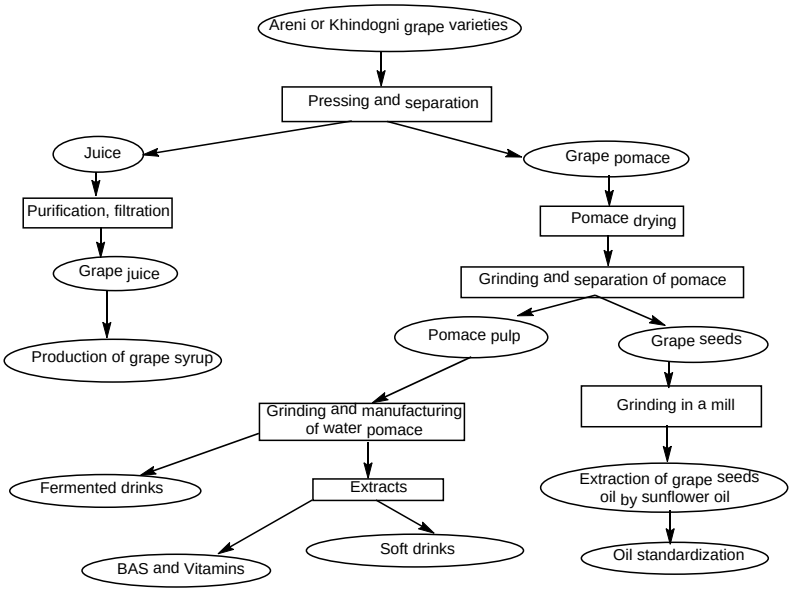


Fig. 2. Technological scheme of complex processing of grape raw materials.

Results and Discussion. The seeds of Khindoghni and Areni grapes are pear-shaped. The mass of the seed is 38–42 *mg*, length is 6.5–6.9 *mm*, widths is 3.7–4.4 *mm*, thickness is 2.2–3.0 *mm*. The mass fraction of grape seeds averaged 21% of the mass of dried pomace, about 5.6% of the mass of berries; the yield of 0.25–0.45 *mm* of crushed seeds was 92–94%.

Analysis of the main physicochemical indicators of the raw materials under study is presented in Tab. 1.

Table 1

Quality indicators of the seeds of Khindoghni and Areni grape varieties

Indicators	Characteristics	
	Khindoghni	Areni
Appearance	the surface of the seeds is clean without any traces of mold	
Color	brown, typical for this grape variety	
Smell	peculiar to grape seeds	
Humidity, %	5.5 ± 0.2	5.4 ± 0.2
Ash, %	3.4 ± 0.3	3.3 ± 0.3
Ash insoluble in 10% HCl,%	0.042 ± 0.004	0.041 ± 0.003

It follows from the data presented in Tab. 1 that the studied seeds are of high quality according to commodity indicators and can be used to obtain grape oil. Organoleptic and physicochemical characteristics of oil samples obtained by the extraction method using unrefined sunflower oil as an extractant were determined. The results are shown in Tab. 2.

Table 2

Organoleptic and physicochemical indicators of oil from grape seeds of Khindoghni and Areni varieties

Indicators	Oil characteristics	
	Khindoghni	Areni
Appearance and color	Transparent oily liquid of yellow color with a greenish shade	
Smell	Weak aroma	
Solubility	Soluble in chloroform, benzene, acetone, diethyl and petroleum ether, slightly soluble in alcohol 95%; practically insoluble in water	
Density, g/cm^3	0.9224	0.9225
Refractive index	1.4712	1.4721
Acid number, *mg* KOH/*g*	0.38	0.41
Saponification number, *mg*/100*g*	176.857	176.869
Iodine number, *mg* I_2 / *g*	76.03	76.09
Peroxide number, *mmol* O_2/*kg*	7.886	7.897
Process yield, %	9.50	9.45

The optimal conditions for obtaining high quality unrefined grape oil for the food and pharmaceutical industries from the grape seeds of Khindoghni and Areni varieties by the extraction method were determined: temperature 45–50°C, at atmospheric pressure, stirring time 16 *h*. Under these optimal conditions the oil yield was 9.5%.

Comparative data on the content of biologically active substances in primary pomace formed after processing of grape seeds of Khindoghni and Areni varieties are shown in Tab. 3.

Table 3

Comparative content of BAS in primary pomace of Khindogni and Areni grape varieties

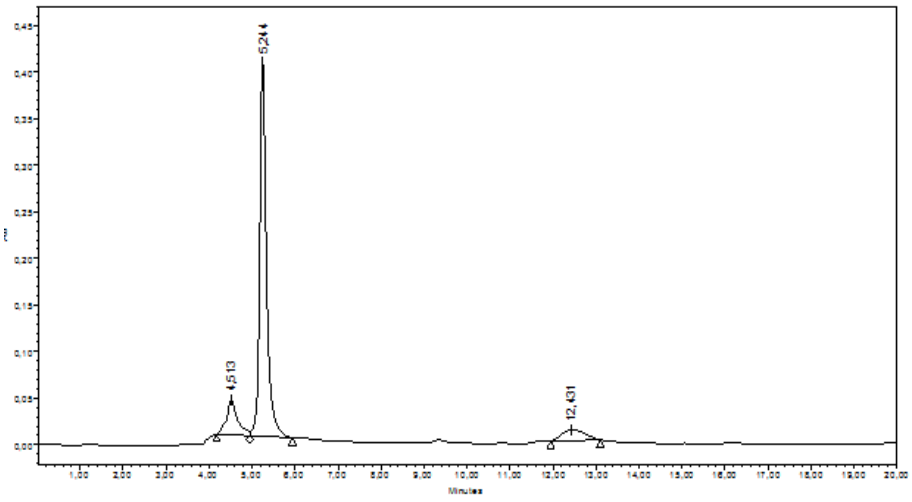
Indicators of BAS	Quantity, %	
	Khindoghni	Areni
Moisture	5.3	5.18
Flavonoids	0.171	0.176
Anthocyanins	0.4798	0.4800
Tartaric acid	79.9 (3.105 *mg*/*mL*)	79.8 (3.104 *mg*/*mL*)
Oxalic acid	12.24 (0.093 *mg*/*mL*)	12.22 (0.091 *mg*/*mL*)
Citric acid	7.86 (0.48 *mg*/*mL*)	7.83 (0.46 *mg*/*mL*)
Vitamin C	96.25 *mg*/*mL*	96.30 *mg*/*mL*
Vitamin P	0.169 *mg*/*mL*	0160 *mg*/*mL*
Tannins	0.7	0.62
Carotenoids	4.6 *mg*/*mL*	4.7 *mg*/*mL*
Extractive substances	24.66	24.62

According to Tab. 3, the studied pomace of Khindoghni and Areni grapes contain free organic acids (tartaric, oxalic and citric), vitamins (C, E, P), flavonoids, anthocyanins, tannins and other biologically active substances that provide a wide range of pharmacological action of the plant: immunomodulatory, anti-inflammatory, traumatic, medicinal, antioxidant, etc.

The fruits, seeds and primary pomace used for processing Khindoghni and Areni grapes are excellent raw materials for the production of high quality oil, which is in high demand on the world market in the food, cosmetic and pharmaceutical industries, as well as for the production of juices, extracts and some free organic acids: oxalic, tartaric and citric. The insignificant content of oxalic acid in the fruits and processed products of Khindoghni and Areni grape varieties does not pose a danger to the human body; in particular, it cannot lead to acute renal failure.

In the food industry tartaric acid is registered as E334 additive – the acidity regulator or pH in the manufacture of pastry and bakery products: sweets, marmalade, jams, jellies, fruit and berry ice cream, canned foods, juices, soft drinks, table water and wine products. Citric acid is widely used as a flavoring agent, acidity regulator and preservative in the food industry (food additives E330–E333), in the production of processed cheeses, drinks, dry mixtures for the preparation of effervescent drinks.

The content of free organic acids in the extract of primary pomace of Khindoghni grape variety is presented in Fig. 3.



	Name	Retention Time	Area	% Area	Height	Conc. (mg/mL)
1	Oxalic acid	4,513	679177	12,24	37803	0,093
2	Tartaric acid	5,244	4435190	79,90	403828	3,105
3	Citric acid	12,431	436523	7,86	11866	0,48

Fig. 3. Content of free organic acids in the extract of primary pomace of Khindoghni grape variety.

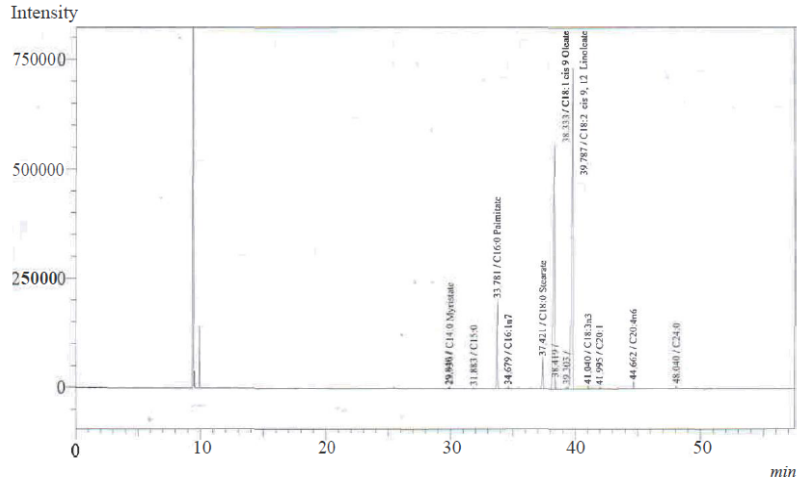
According to Tab. 4 the main components of oil from grape seeds of Khindoghni and Areni varieties harvest of 2019–2021 are: diunsaturated linoleic acid (omega-6) about 40.589–50.890% and monounsaturated oleic acid (omega-9) 28.453–36.383%, and from the limiting range: palmitic acid about 5.980–7.154% and stearic acid 2.945–3.226%. Unsaturated acids are also represented by polyunsaturated linolenic acid (omega-3) and monounsaturated palmitoleic acid (omega-7), about 0.199–0.218% and 0.119–0.137%, respectively, and saturated ones – by myristic acid about 0.135–0.149% (Fig. 4).

Table 4

Fatty acid composition and content of biologically active substances in the samples of Khindoghni and Areni oils obtained from grape seeds with sunflower oil in case of carbon dioxide gasbag

Indicators	Temperature of extraction, °C		Literature data [22]
	45	50	15*
	Khindoghni	Areni	
Fatty acid composition, %			
Myristic acid	0.149	0.135	0.63 ± 0.03
Palmitoleic acid (omega-7)	0.137	0.119	0.24 ± 0.07
Palmitic acid	7.154	5.980	7.43 ± 0.02
Linoleic acid (omega-6)	50.890	40.589	70.53 ± 0.04
Oleic acid (omega-9)	36.383	28.453	17.03 ± 0.02
Linolenic acid (omega-3)	0.218	0.199	0.54 ± 0.01
Stearic acid	3.226	2.945	3.75 ± 0.05
Tocopherols	181.1	178.1	289 ± 1

*** –** the composition of the oil obtained from the seeds of Rkazteli by CO_2 extraction is presented.



Peak#	Ret.Time	Area	Height	Conc.	Unit	Mark	ID#	Cmpd Name
2	29.936	17399	4217	0.149	%	V	8	C14:0 Myristate
3	31.883	4412	918	0.038	%		10	C15:0
4	33.781	833870	202252	7.154	%		12	C16:0 Palmitate
5	34.679	15945	4114	0.137	%		13	C16: ln7
6	37.421	376037	70035	3.226	%		16	C18:0 Stearate
7	38.333	4240869	558020	36.383	%	V	18	C18:1 cis 9 Oleate
10	39.787	5931780	732228	50.890	%	V	20.	C18:2 cis 9, 12 Lin
11	41.040	25389	5929	0.218	%		22	C18:3n3
12	41.995	15488	3561	0.133	%	V	24	C20:1
13	44.662	69350	16195	0.595	%		28	C20:4n6
14	48.040	23191	5365	0.199	%		35	C24:0
Total		11553730	1602834					

Fig. 4. Gas chromatography chromatogram of the fatty acid composition obtained from grape seeds of Khindoghni variety.

The results of studies of the elemental composition in the seeds and in the remains of seeds of Khindoghni and Areni grapes indicate the presence of more than 20 elements, including macro- and microelements. In particular, a higher content of Al, Fe, Zn, Cu, K Ca, Mg, Na was found. The results are shown in Tab. 5.

Table 5

Content of micro- and macroelements in the seeds and in the remains of seeds of Khindoghni and Areni grapes

Element	Concentration, *mg*/*kg*				Wavelength, *nm*
	Khindoghni seeds	remains of Khindoghni seeds	Areni seeds	remains of Areni seeds	
Ag	0.00	0.00	0.00	0.00	328.068
Al	99.44	247.74	107.09	217.09	396.15
As	0.00	33.20	0.00	25.54	234.984
Ba	7.65	7.66	3.82	2.55	455.403
Be	0.00	0.00	0.25	0.00	313.042
Ca	4997.45	6096.44	7011.73	7248.30	422.673
Cd	0.00	0.00	0.00	0.00	214.439
Co	0.00	0.00	0.25	0.00	238.892
Cr	7.65	7.66	3.82	11.49	267.716
Cu	28.05	33.20	56.09	71.51	324.754
Fe	140.23	778.98	152.98	1024.16	238.204
K	31820.50	254890.94	51453.34	226285.95	766.491
Mg	2246.30	1861.88	2677.21	2329.26	280.270
Mn	7.65	7.66	7.65	12.77	257.610
Mo	0.00	0.00	0.00	4.34	202.032
Na	5762.37	7917.45	7037.23	12003.88	589.592
Ni	2.55	5.11	0.00	2.55	216.555
Pb	0.00	0.00	2.55	0.00	283.305
Sb	43.35	43.42	43.35	17.88	206.834
Se	0.00	0.00	0.00	0.00	196.026
Sr	79.04	91.94	58.64	40.86	421.552
Tl	0.00	0.00	0.00	0.00	190.794
V	0.00	2.55	0.00	5.11	309.310
Zn	163.18	48.53	206.53	63.85	213.857

Conclusion.

1. Optimal conditions for obtaining oil from the seeds of Khindoghni and Areni grape varieties by the extraction method were: temperature 45–50°C, at atmospheric pressure and carbon dioxide gasbag (CO_2), stirring time 16 *h*. Under these conditions the yield of grape oils was consequently 0.68–0.72 *kg* (0.74 dm^3) from 1 *kg* of grape raw materials.

2. Industrial grape varieties of Khindoghni and Areni are characterized not only by a high content of essential unsaturated fatty acids: diunsaturated linoleic acid (omega-6) about 40.589–50.890% and monounsaturated oleic acid (omega-9) 28.453–36.383%, but also saturated ones: palmitic acid about 5.980–7.154% and stearic acid 2.945–3.226%. Unsaturated acids are also represented by polyunsaturated linolenic acid (omega-3) and monounsaturated palmitoleic acid (omega-7) about 0.199–0.218% and 0.119–0.137%, respectively, and saturated ones – by myristic acid 0.135–0.149%.

3. It has been shown that oils from the seeds of Khindoghni and Areni grape varieties contain 1.181 *mg*/100 *g* tocopherols, 3.2 *mg*/100 *g* carotenoids, vitamins C, P, E and the pomace of their processing contains valuable free organic acids: 0.091–0.093 *mg*/*mL* oxalic, 3.104–3.105 *mg*/*mL* tartaric, 0.46–0.48 *mg*/*mL* citric.

4. It has been shown that the content of macro- (Fe, Cu, Zn, Ca, Mg, etc.) and microelements (Mn, Co, Cd, V, Se, Cr, As, Pb, etc.) in the seeds of the studied samples are within permissible limits.

5. The fruits, seeds and primary pomace used for processing Khindoghni and Areni grapes are excellent raw materials for the production of high quality oil, which is in high demand on the world market in the food, cosmetic and pharmaceutical industries, as well as for the production of juices, extracts and some free organic acids: oxalic, tartaric and citric.

6. On the basis of the research carried out, a scheme for complex processing of grape raw materials has been developed.

Received 17.12.2021
Reviewed 17.01.2022
Accepted 31.01.2022

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ԽԱՂՈՂԻ ԿՈՐԻԶՆԵՐԻ ՅՈՒՂԻ ԵՎ ՔՈՒՍՊԻ ՀԵՏԱԶՈՏՈՒԹՅՈՒՆԸ՝ ԴՐԱՆՑ ՀԱՄԱԼԻՐ ՎԵՐԱՄՇԱԿՄԱՆ ՆԱԽԱԴՐՅԱԼՆԵՐԻ ԲԱՑԱՀԱՅՏՄԱՆ ՆՊԱՏԱԿՈՎ

Աշխատանքը նվիրված է լուծամզման եղանակով ստացվող խաղողի կորիզների յուղերի օրգանոլեպտիկ ցուցանիշների և մնացորդային քուսպի հետազոտմանը՝ հետագա կիրառման հեռանկարների բացահայտման նպատակով:

Հետազոտման առարկա են հանդիսացել Հայաստանում աճեցված Խինդողնի և Արենի խաղողի տեսակների կորիզները, որոնք հավաքվել են 2019–2021 թթ.-ին: Աշխատանքի նպատակն էր իրականացնել ստացված յուղերում ճարպաթթուների որակական և քանակական ցուցանիշների որոշում՝

գազահեղուկային քրոմատոգրաֆիայի մեթոդով: Որոշվել են սննդի և դեղարդյունաբերության մեջ կիրառվող բարձրորակ, չռաֆինացված խաղողի կորիզի յուղի ստացման օպտիմալ ցուցանիշները (16 *ժ,* 45–50°C ջերմաստիճանում, մթնոլորտային ճնշման և ածխաթթու գազի ներկայությամբ) Խինդողնի և Արենի տեսակներից լուծահանման եղանակով: Նշված պայմաններում յուղի ելքը կազմել է 9,5%: Ցույց է տրվել, որ Խինդողնի և Արենի տեսակների կորիզներից ստացված յուղերում պարունակվում են 1,181 *մգ*/100 *գ* տոկոֆեռոլներ, 3,2 *մգ*/100 *գ* կարոտինոիդներ, վիտամիններ C, P, E, իսկ դրանց մշակման արգասիքներում՝ կարևոր ազատ օրգանական թթուներ. 0,093 *մգ/մլ* թրթնջկաթթու, 3,104–3,105 *մգ/մլ* գինեթթու և 0,46–0,48 *մգ/մլ* կիտրոնաթթու:

Ցույց է տրվել նաև, որ մակրո- և միկրոտարրերի պարունակությունը թույլատրելի սահմաններում է: Կատարված հետազոտությունների հիման վրա մշակվել է խաղողի հումքի համալիր վերամշակման տեխնոլոգիա:

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ИССЛЕДОВАНИЕ МАСЛА И ВЫЖИМОК ИЗ КОСТОЧЕК ВИНОГРАДА ДЛЯ ВЫЯВЛЕНИЯ ПРЕДПОСЫЛОК ДЛЯ ИХ КОМПЛЕКСНОЙ ПЕРЕРАБОТКИ

Работа посвящена сравнительному исследованию физико-химических, органолептических показателей масел, полученных экстракционным методом с применением подсолнечного масла, и оставшихся после их переработки выжимок с целью выявления предпосылок для их дальнейшего использования. Объектом исследования являлись косточки технических сортов винограда Хиндогни и Арени (выращенных в Республике Армения) урожая 2019–2021гг.

Целью настоящего исследования являлось определение сравнительных показателей качества и содержания жирных кислот в виноградных маслах методом газожидкостной хроматографии. Определены оптимальные условия получения высококачественного нерафинированного виноградного масла для пищевой и фармацевтической промышленности из косточек винограда сортов Хиндогни и Арени экстракционным методом: температура 45–50°C при атмосферном давлении и углекислой газовой подушке, время перемешивания 16 *ч*. В этих оптимальных условиях выход масел составил 9,5%. Показано, что масла из косточек сортов Хиндогни и Арени содержат токоферолы – 1,181 *мг* /100 *г*, каротиноиды – 3,2 *мг* /100 *г*, витамины C, P, E, а выжимки их переработки содержат ценные свободные органические кислоты: щавелевую – 0,093 *мг/мл*, винную – 3,105 *мг/мл*, лимонную – 0,48 *мг/мл*. Показано, что содержания макро- (Fe, Cu, Zn, Ca, Mg и т.д.) и микроэлементов (Mn, Co, Cd, V, Se, Cr, As, Pb и т.д.) в косточках исследованных образцов находятся в пределах допустимых норм. На основании проведенных исследований разработана схема комплексной переработки виноградного сырья.