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METHODS OF PROCESSING GRAPES FOR THE PRODUCTION OF FUNCTIONAL DRINKS

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Abstract

The article describes technological methods for processing grape berries and secondary products of their processing. An important source of biologically active substances is grape pomace, seeds, and skins, which contain a significant number of essential compounds. From grape pomace, tartaric acid salts, CO_2 extracts, grape oil, resveratrol, and plant-based flour are obtained.

An improved structural scheme for producing clarified grape juice using CO_2 detartrating has been developed. A process flow diagram for grape processing has been designed. The chemical composition of grape seeds cultivated in the Republic of Uzbekistan has been studied. The content of resveratrol in a CO_2 extract obtained from grape skins has been determined. The amino acid composition of grape seed cake from the red Aleatico variety, obtained using the CO_2 method, has been analyzed.

Keywords

Natural oil, grape seed oil, CO_2 extract from grape berries, biologically active substances, Phyto concentrate, resveratrol, plant powder.

Introduction. Priority areas for the development of the food industry include improving technological methods for processing berries.

Grapes and their processed products. The natural climatic conditions of the Republic of Uzbekistan are favorable for the cultivation of high-quality grapes, which has contributed to the rapid development of viticulture. The Republic of Uzbekistan has developed a national target program, "Development of Viticulture," and active work is underway to implement it.

An important source of biologically active substances is grape pomace, which consists of non-exchangeable compounds from the seeds and skins. Grape pomace can be used to obtain tartaric acid salts, CO2 extracts, grape seed oil, resveratrol, vegetable flour, and pectin.

Research objects and methods

The objects of the study were the seeds of grape varieties grown in the Republic of Uzbekistan: Aleatiko, Bayan Shirey, Hungarian Muscat, Rkasiteli, Saperavi, Soyaki, Ak Toif.

Research results

Natural grape juice is one of the most popular products in most countries worldwide. However, currently used grape juice production technologies do not always guarantee the production of high-quality products. Industrial grape processing generates large quantities of secondary resources [1-3].

Figure 1 shows an improved flow chart for the production of crystal-stabilized grape juice.

Figure 1 - Flow chart of grape juice production

The qualitative characteristics of the raw materials were assessed using modern research methods applied in the Republic of Uzbekistan.

The content of tartaric acid salts was determined by precipitation of the precipitate with a mixture of alcohol and ether, followed by titration with NaOH.

The calcium tartaric acid content was determined by manganometric analysis. Protein and amino acid fractions in the samples were determined by capillary electrophoresis. Lipids were determined by the Soxhlet method using a Kapel-105 M apparatus, and fatty acid composition, vitamins A, D, and E were determined by gas-liquid chromatography.

Unsolved problems include the effective removal of crystalline sediments from grape juice and wine materials.

These are mainly acidic potassium salts of tartaric acid, which, despite having a certain nutritional value, complicate technological processes and significantly degrade the quality of the product, making it unfit for sale.

The main condition for obtaining high-quality food products:

According to the requirement, no more than four hours must pass from the grape harvest to processing. Since grape juice production is seasonal, processing plants are located near the vineyards, using vehicles to deliver the grapes to the processing plant (in special containers or carts), where they undergo inspection procedures. The method of extracting juice from the grapes significantly influences the quality of the final product.

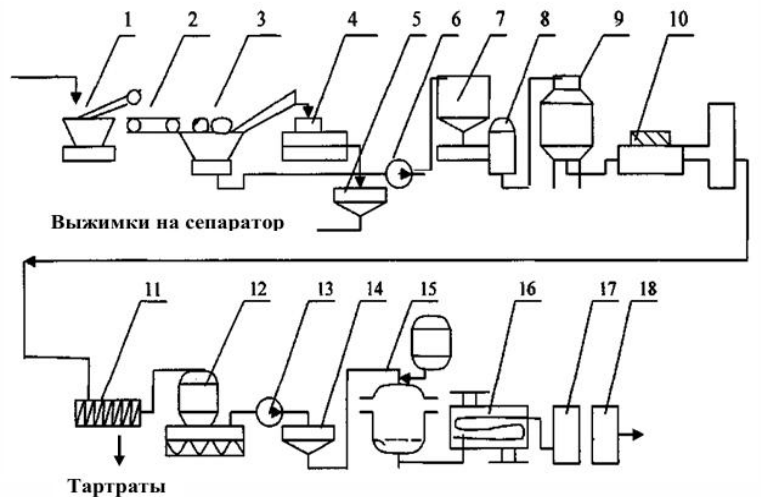
The best quality juice is obtained in a gravity-fed juicer, separating it from the grape pulp crushed by rollers. The pulp obtained after juicing is a by-product of berry processing.

An original method for removing tartaric acid salts from grape juice using granulated solid carbon dioxide (detartaration) has been developed. It was developed with the participation of N.S. Podshivalenko and involves the formation of artificial crystallization centers using microgranules of solid carbon dioxide [4].

Hungarian grape varieties Aleatico, Bayan Širei, and Muscat were processed. The grapes were washed, screened, crushed, and pressed [5]. The resulting juice was filtered through perlite and metal-ceramic filters, subjected to a CO2 detartarization step, pasteurized, and bottled hot.

Other objects of study included grape pomace, seeds, and grape skins formed during grape processing. The resulting grape pomace was separated by flotation.

Figure 2 shows the apparatus and process flow diagram for processing grape berries and obtaining grape juice using CO2 detartaration. The $_{CO2}$ descaling device served as a $_{granulator,}$ with carbon dioxide supplied from a pressurized cylinder through a gas cylinder, converting the CO2 $_{from}$ a liquid to a solid (dry ice). The granulator's design allowed for the production of solid CO2 granules $_{of}$ varying diameters.

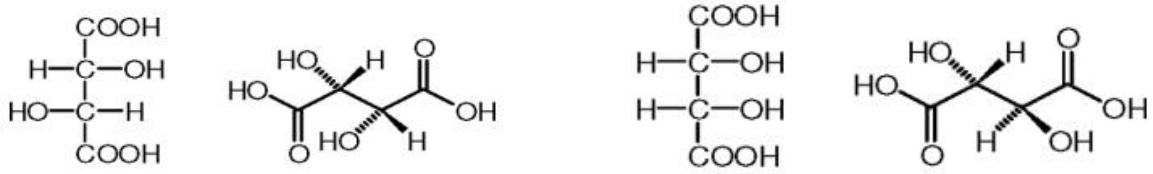


1 – washing machine; 2 – inspection conveyor; 3 – crusher; 4 – press; 5 – tank for suspensions and pressed juice; 6, 13 – pumps; 7, 14 – collectors; 8 – dispenser; 9 – perlite filter; 10 – fine filter; 11 – decanter; 12 – $_{CO2}$ detarter ; 15 – CO2 concentrator , 16 – pasteurizer; 17 – filling machine; 18 – capping machine.

Figure 2 – Apparatus and flow chart for processing grapes and obtaining grape juice using the CO_2 detartarization method.

Grape seed oil is an antitoxic agent for chemical poisoning. Due to its high vitamin P content, grape seed oil promotes hematopoiesis and influences the blood clotting system.

A distinctive feature of the above-described scheme from existing ones is the removal of potassium salts of tartaric acid by gas-liquid detartaration. Tartaric acid typically consists of potassium hydrogen tartrate $KC_4H_5O_6$ and potassium tartrate $K_2C_4H_4O_6$. Tartaric acid isolated from grape juice mainly contains acidic substances: potassium tartaric acid – 83%, calcium tartaric acid – 9%, and other substances – 8%. Tartaric acid is obtained by treating the seed with mineral acids. This acid contains two identical carbon atoms of an asymmetric structure:



L- shape wine acids meso-tartaric acid in the form

L-tartaric acid is the optical antipode of d-tartaric acid and is very similar to d-tartaric acid in its physicochemical properties, but rotates the plane of polarization of light to the left.

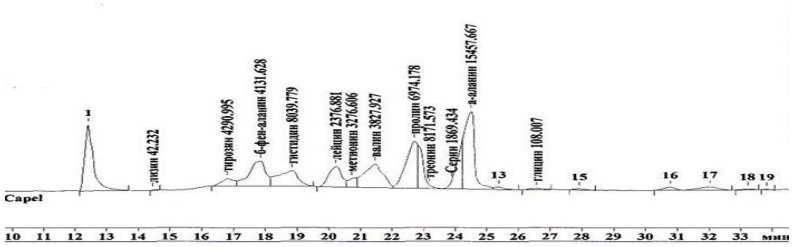
Table 1 shows the composition of grape pomace, seeds and skins obtained during grape processing.

Table 1 - Composition of additional raw materials in the process of grape processing

Name of plant material	Exit, %
Grape pomace	9
Grape seeds	11
The skin of red grapes	3
Resveratrol in $CO2_{extract}$ from red grape skins	0.4

The chemical composition of grape seeds was determined based on the content of valuable unsaturated omega-6 and omega-3 fatty acids and polyunsaturated fatty acids. The researchers refined a CO2 extraction technology $_{based}$ on the unique ability of liquid and flowing carbon dioxide to extract raw materials, taking into account the constant complex of biologically

active substances in the pulp, skin, and seeds of grapes. The amino acid composition of CO2 flour from Aleatico grape seeds was studied (Fig. 3).



No	Time min	Height mAU	Square mAU *sec	FO	Conc. mg/kg	Conc. %	Name
1.	14.456	0.0036	0.0369	55,000	42.2323	0.0721	lysine
2.	16,796	0.0298	0.8252	250,000	4290.9951	7.3267	tyrosine
3.	17,830	0.0975	3.6116	55,000	4131.6279	7.0545	phenyl alanine
4.	18.818	0.0598	2.7609	140,000	8039.7788	13.7275	histidine
5.	20.210	0.0790	2.2855	50,000	2376.8809	4.0584	leysin
6.	20.703	0.0344	0.6564	240,000	3276.6057	5.5946	metionin
7.	21.453	0.0924	3.8341	48,000	3827.9272	6.5360	Valin
8.	22,694	0.1826	4.4706	75,000	6974.1777	11.9081	proline
9.	23.170	0.0122	2.0677	190,000	8171.5732	13.9525	threonine
10.	23,878	0.0346	2.3652	38,000	1869.4338	3.1920	serin
11.	24.487	0.3001	6.7560	110,000	15457.6670	26.3932	alanine
12.	26,56	0.004	0.1208	43,000	108.0068	0.1844	Glycin

4	5					
3 4.5 8 8	0.9 0 6	3	2 9.7 0 7	9 1965.94 5	58566.906 6	100,000 0

Figure 3 - Amino acid composition of CO2 - extract of Aleatico grape seed cake

The parameters of moisture, protein and lipid content in seeds were determined experimentally.

The moisture content of the seeds of the Aleatico variety was 6.57%, and that of the Soyaki variety was 5.62%, the protein content of the seeds of both varieties was 60%, and the oil content was 30-31%.

As the data presented demonstrates, CO2 - treated grape seed flour retains a relatively high content of essential amino acids. It is proposed to extract these valuable components from red grape skins using CO2 -based gas-liquid extraction.

Specifically, it was found that 1 g of CO2 extract contains 50 to 100 mcg of the powerful natural antioxidant resveratrol, which is 4-5 times more active than β-carotene, 50 times more active than vitamin E, and 20 times more active than vitamin C. Resveratrol's cardioprotective properties are well-known. Its antioxidant properties are based on the formation of superoxide anion and hydrogen peroxide in the body.

The content of resveratrol in the CO2 extract from red grape skin was determined by HPLC according to the method of E.V. Rilina [6, 10–28].

The absorption maxima of cis- and trans-resveratrol were determined by liquid chromatography using diode array spectroscopy at wavelengths of 215-310 nm (Fig. 4).

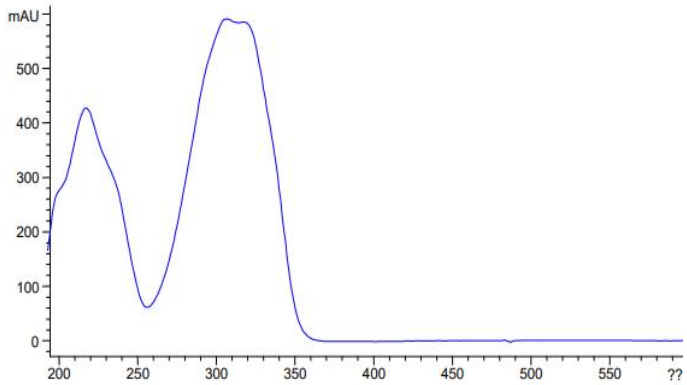


Figure 4 - Red grape skin

UV spectrum of resveratrol solution obtained by CO2 extraction

CO2 extract was obtained from the skins of red Soyaki grapes at a late stage of ripening.

Grape skins and pulp (51% moisture) accounted for 46% of the product. Their bulk density was 340 g/dm³, and their specific gravity was 1.1 g/cm³. To obtain CO2 extract from dried red grape skins, we used a laboratory extraction device.

Fig. 5. Laboratory equipment for studying the process of extracting ingredients from plant material using CO 2.

Table 2 describes the methods of using CO2 extract as therapeutic and prophylactic agents and their costs. Based on the results:

Based on previous studies, recommendations were prepared for the perfume, cosmetic and bakery industries on the use of CO2 extract and other grape berry processing products [7-9].

Table 2 - Recommendations for using CO2 extract

Name of CO2 - extracts for use in the perfume, cosmetic and bakery industries	Price per 1 kg, sum
CO2 - extract from grape pomace. In perfumery and cosmetic products, it is used as a component with a moisturizing and mild antioxidant effect. Recommended for use in skin care products for aging, flaking, and problematic skin. CO2 - meal from grape pomace Nograda is recommended for enrichment of bakery products.	2,098,000
CO2 - extract from grape pomace. In perfumery and cosmetic products, it is used as a component with a moisturizing and mild antioxidant effect. Recommended for use in skin care products for aging, flaking, and problematic skin. CO2 - meal from grape pomace Nograda is recommended for enrichment of bakery products.	2,234,000
CO2 - extract from the skin of grapes. Used in cosmetic products is used as a component with anti-inflammatory, wound-healing properties with a restorative and regenerating effect. Recommended for use in eye	2,344,000

care products.	
Resveratrol from red grape skin CO2 extract regulates fat metabolism in the human body and increases resistance to low-density lipoprotein oxidation. It is recommended for use as a preventative measure against atherosclerosis.	8,484,000

CO_2 extracts from red grape fruits, dried grape pomace, seeds and skins are in high demand in many industries.

Conclusion. The structural scheme for producing clear grape juice using CO2 detartration has been improved. A process flow diagram for grape processing has been developed. The chemical composition of grape seeds grown in the Republic of Uzbekistan has been studied. The resveratrol content in the CO2 extract from grape skins has been determined. The amino acid composition of the flour from the seeds of the red Aleatico grape variety, obtained using CO2 extraction, has been determined.

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