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Food and Ecological Safety of Grape By-Products

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Abstract **– The import substitution program contributed to intensive growth of domestic viticulture and winemaking. In the southern regions of Russia, more than 250 thousand tons of grapes are processed into juice and wine every year. More than 50 thousand tons of grape pomace can be used for producing more than 1 thousand tons of grape oil and tens of tons of protein filler, dietary fiber, pectin and organic acids. However, secondary raw materials are usually not immediately sent for processing. Therefore, grape by-product safety issues are relevant. The article suggests methods for processing by-products of grape varieties grown in the Chechen Republic. It describes a method of gentle drying of grape pomace which preserves maximum valuable components. Technological parameters for extracting valuable components from dry grape seeds and skins using liquid carbon dioxide are suggested.**

Information for identifying the chemical composition of carbohydrate-protein-lipid meal from grape seeds and recommendations on its use as a food fortifier are given. Technological methods for producing natural food supplements from secondary products of viticulture and winemaking involve using a new class of supplements - CO2-extracts and CO2-meal from seeds and skin of the grape variety grown in Naursky district of the Chechen Republic. Owing to developed comprehensive preventive measures, strict production control of all production stages can be carried out and measures aiming to ensure safety of fortified products and prevent food diseases can be taken. The study confirmed food and ecological safety of products which contribute to human health.

Keywords – grapes, secondary materials, product safety, food supplements.

I. INTRODUCTION

In recent years, the social movement "For Healthy Lifestyle" is associated with a healthy diet. The issue of food security dealing with organization of organic farming and environmentally friendly methods of processing agricultural products is crucial. Grape by-products expand the range of healthy food products.

In the Russian Federation, more than 350 thousand tons of grapes are grown per year and the same amount is imported. About 200 thousand tons of grapes are harvested in Krasnodar Krai, 160 thousand tons – in the Republic of Dagestan, about one thousand tons of grapes – in the

Chechen Republic. If you process 250 thousand tons of juice and wine, more than 50 thousand tons of grape pomace can be produced. It can be processed to get more than 1 thousand tons of grape oil and tens of tons of protein filler, dietary fiber, pectin, and organic acids.

However, producers of secondary viticulture and winemaking products face some dangers associated with the quality of materials sent for recycling. It is known that grape pomace contains a significant amount of beneficial substances that can serve as food for microorganisms. If wet grape pomace is processed a few hours after its production, spores of molds and yeast multiply in it. In addition, it can contain pesticides, bacterial toxins and unwanted chemicals. Therefore, it is necessary to control product safety throughout the whole production chain: from grape growing and processing to transportation and storage.

Scientific and technical literature provides information on how to divide grape pomace into seeds and skins [3,6]. It was established that dry, non-fermented extract contains 25% of seeds, 25% of crests and 50% of skins. Grape seeds and skins contain phenolic substances, including anthocyanins, which are responsible for deactivation of free radicals [9]. Grape processing product antioxidants are used to enrich the composition of new dairy products [1]. The most effective way to obtain oil from grape seeds is CO2-extraction [2]. The study on antimicrobial properties of grape seed and skin extracts confirmed their high activity against oral anaerobes [4]. The studies on properties of red grape seed and skin extracts containing catechins, epicatechin, quercetin, rutin, and resveratrol are of special interest [5]. Specialists from Macedonia used flash chromatography for preliminary division of multicomponent grape seed and skin extracts [7,8]. A number of researches dealt with methods for producing extracts from grape pomace of different grape varieties and using them to enrich various food products [10-14].

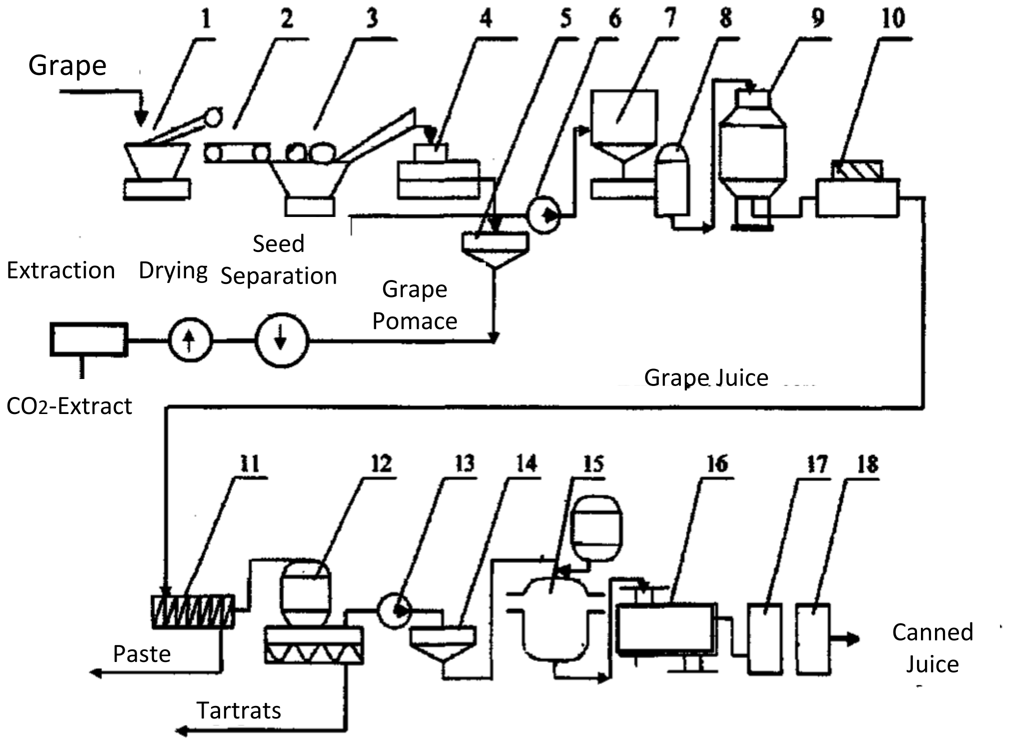

Fig. 1. Instrumental circuit of gas-liquid grape processing: 1- machine for washing grapes; 2- control conveyor; 3- grinding machine; 4- press; 5- bunker for combs and husks; 6, 13- pumps; 7,14- collectors; 8- dispenser; 9- filter; 10- fine filter; 11 tricanter; 12 -CO2 - detartrator; 15-CO2 concentrator; 16- pasteurizer; 17 - filler; 18- seamer.

II. Research Objectives and Methods

The article aims to study the need for deep processing of secondary products of grape varieties grown in the Chechen Republic. A new method for producing and applying grape seed and skin extracts is described.

The authors aim to evaluate the food and environmental safety of grape by-products, suggest new methods of drying and dividing grape pomace into fractions, investigate the chemical composition of CO2-extracts from grape seeds and skins, justify the use of extracts and CO2-meal for enriching food products.

The colorimetry method was used to study the quantitative content of phenolic substances and polysaccharides in grape by-products.

Antioxidant properties of grape seed and skin extracts were assessed using semi-preparative HPLC with an amperometric detector. To divide acylated and non-acylated anthocyanins, Sephadex was used at different swelling rates.

III. Results

The research results are as follows.

The yield of alcohol, wine-stone lime and grape seeds during grape processing for wine was studied (Table 1). Figure 1 shows the scheme of integral grape processing

TABLE 1 TYPES OF PRODUCTS RESULTED FROM GRAPE POMACE PROCESSING

Types of products	From 1 t sweet pomace	From 1 t ferment pomace	From 100 daL yeast (dried)
Crude-spirit, daL	2.89	5.02	9.69
VKI of 3% humidity, kg	8.25	16.5	50.8
Grape seeds of 7 % humidity, kg	136	135	-

Figure 2 shows the scheme of grape seed processing

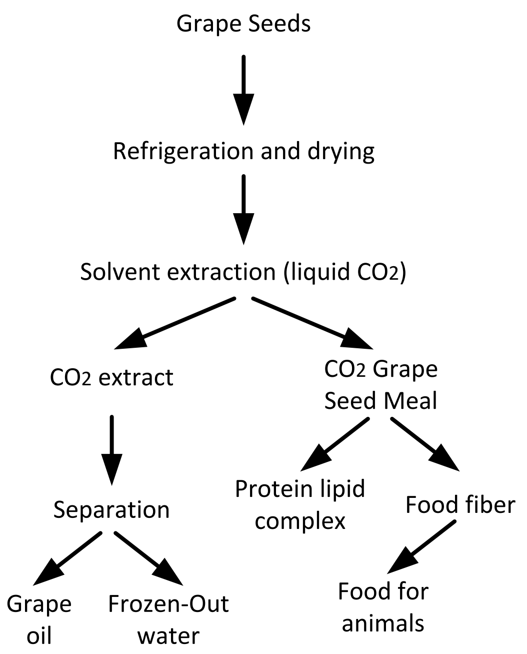

Fig. 2. Structural scheme of grape seeds processing

Figure 3 shows the scheme of a rotor for IR grape pomace evaporation.

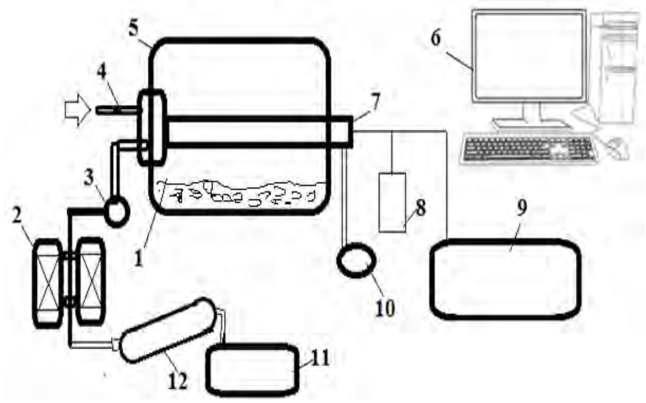

Fig. 3. Scheme of a rotor for IR grape pomace evaporation: 1- raw materials for drying, 2-scrubber, 3-pump, 4-loading device, 5-dryer body, 6-PC, 7-gas ceramic IR inductor, 8-LF ionizer, 9-capacity for natural gas, 10 - vacuum pump, 11-capacity for CO2, 12-condenser

Operating parameters of the infrared drying unit are as follows: vacuum depth P is 720 Torr; extraction temperature at the beginning of drying $t_{нач}$ varies between 25 and 30°C; grape pomace layer is l <10 cm in height, density of heat flow *Ep* is up to 2,3 kW / m2. The weight of dry pomace Y is 25 kg / (m^2·h).

Table 2 shows weight ratio of skin components for two grape varieties.

TABLE 2 WEIGHT RATIO OF GRAPE SKIN COMPONENTS

Parameter	Value			
	Valley grape skin		*Foothill grape skin*	
	Magarach's pervenets	Negro	Magarach's pervenets	Negro
Content of skins, %	6.4	7.3	6.6	7.2
Aqua extract pH	4.2	4.3	4.2	4.3
Acids, mg per 1 kg of skins				
Free	92	69	90	70
Salts	139	112	140	122
Sum of cations, mg%	214	185	210	190
Tartaric acid	97	67	95	68
Apple acid	129	109	130	110
Limon acid	8	4	8	5
Sum of anions, mg %	238	179	239	180
Soluble polyphenols, g	2.9	3.3	3.0	3.2

Table 2 shows that grape skins contain a significant amount of organic acids and antioxidants (polyphenols).

Table 3 shows the qualitative composition of CO2-seed and skin extracts

Table 4 shows recipes of national bread products using CO2-extracts and carbohydrate-protein-lipid concentrate (CHPLC).

TABLE 3 QUALITATIVE COMPOSITION OF CO2-GRAPE SEED AND SKIN EXTRACTS

Parameter	Value			
	CO_2-seed extract for		*CO_2-skin extract*	
	Magarach's pervenets	Negro	Magarach's pervenets	Negro
Relative density, kg/m^3	926	931	944	952
Refraction (20 ºC)	1.470	1.475	1.510	1.524
Acid value, mg KOH/g	8.0	8.6	4.5	4.6
Iodine value, g J_2/100 g	134	132	95	90
Saponification, mg KOH/g	188	190	210	216
Fatty acid composition,% of total fatty acids				
Palmitoleic acid	1.1	1.1	1.2	1.2
Steartic acid	3	4	5	4
Palmitic acid	5	6	7	7
Oleic acid	18	19	22	20
Linoleic acid	68	66	59	61
Linolenic acid	5	4	6	6
Arachic acid	0.9	0.9	no	no

TABLE 4 RECIPES OF NATIONAL BREAD PRODUCTS USING CO2-EXTRACTS AND CARBOHYDRATE-PROTEIN-LIPID CONCENTRATE (CHPLC).

Components	Chechen Cottage cheese cake Chepalgash	Chechen pumpkin cake Khingalsh	Chechen corn cake	Chechen scone
CHPLC	6	6	7	8
Milk serum	25	22	-	33
Wheat flour	35	35	10	55.4
Corn flour	-	-	40	-
Pumpkin puree	-	19.5	-	-
Cottage cheese	17.5	-	-	-
Salt	1.2	1.2	1.2	1.2
Sugar	-	2.0	1.4	1.5
CO_2-grape seed extract	0.37	0.37	0.37	0.37
CO_2-grape skin extract	0.03	0.03	0.03	0.03
Mutton fat	-	-	9.5	-
Butter	14.4	13.5	-	-
Sodium bicarbonate	0.5	0.5	0.5	0.5
Water	-	-	30	-
Total	100	100	100	100

IV. CONCLUSION

1. The article justified the need for deep processing of grape pomace which is a secondary material produced from processed grapes.
2. A gentle evaporation method for grape pomace preserving valuable components of raw materials was suggested.
3. Methods for extracting target components from dry grape seeds using liquefied carbon dioxide at the pressure of 7.0 MPa and temperature of 20–25 °C were developed.
4. Technological regimes for extracting catechins, epicatechin, quercetin, rutin and resveratrol from grape skins using liquefied carbon dioxide under pressure of 6.5 MPa and temperature of 18-22 ºC were suggested.
5. The chemical composition of carbohydrate-protein-lipid CO_2-meal of grape seeds was studied, recommendations on its use as a food fortifier were given.

Technological methods for producing natural food supplements from secondary products of viticulture and winemaking involve using a new class of supplements - CO_2-extracts and CO_2-grape seed and skin meal. Owing to the developed comprehensive preventive measures, strict production control of all production stages can be carried out and measures aiming to ensure safety of fortified products and to prevent food diseases can be taken. The study confirmed food and ecological safety of products which contribute to human health.

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