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Secondary raw material resources of wine industry and modern technologies of their utilization

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Abstract

There are discussed the main directions of grape secondary raw materials processing in the leading winemaking countries and the prospects of their application in Georgia.

In Georgia, every year, there are thrown 30-40 thousand tons of solid and liquid wastes of secondary raw materials, remaining after wine processing. Unlike wine, grape processing wastes are enriched with bioactive, natural components having the curative-prophylactic purposes. By utilization of grape secondary resources remaining in unused reserve state, is increase the efficiency of wine production. G

Keywords: Liquid And Solid Wastes; Secondary Raw Material; Efficiency of Use; Wine; Grape

1. Introduction

Every year, our country, like the entire World, tries to find out the ways to ensure an adequate level of food safety to create the necessary base for overcoming the problem of poverty.

The country needs to make decisions that will improve the situation, first of all, in the agricultural sector. Georgia really has great potential to develop this sector, but significant raw material resources in reserve are still unused here, not only due to the lack of appropriate financing, but also due to the constant instability in the country's political life.

When processing the grapes into wine, up to 20% of secondary raw materials and wastes are remaining, the main of which are stems - 1-7%; pressed fraction - 10-14%; seeds - 3-4%; yeast lees - 2.5-6%; when producing wine materials: wine stone - 0.5-2 kg per 100 dal of cognac remaining liquid (approximately 2/3 of the volume of the distilled wine-material); thick lees - up to 3 dal per 100 dal of grape juice or wine-material; clarification lees - up to 0.9 dal per 1 dal of 20% bentonite suspension, which is used for clarification[1].

To the problem of the limited availability of natural resources and their rational use are also faced the scientists-economists, who have recently been paying more attention to these issues. In the beginning of the 20th century, American economist Harold Hotelling has published an article with the title “The Economics of Exhaustible Resources” (in the “Journal of Political Economy”), which is dedicated to the problem of rational use of resources, as well as the volume and cost of their application under monopoly conditions [2].

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The issue of utilization of winemaking secondary raw materials in Georgia is extremely acute and still not resolved, together with problems such as low grape yields, increased competition after Georgia's accession to the World Trade Organization, pollution of the environment by industrial waste, etc.

The aim of this article is to demonstrate the economic feasibility of winemaking secondary products processing on the basis of experience of developed countries, as well as systematic studies carried out at the Georgian Scientific-Research Institute of Food Industry.

Edible plant raw materials, usually in addition to the target main product, contain a number of naturally active biological components that remain in production waste after processing and can be used in their own straight, known direction. In addition, the waste as a secondary raw material is best suited for obtaining natural food additives (natural flavorings, colorants, functional non-alcoholic beverages and others).

The history of winemaking in Georgia is thousands of years old, so the scientific approach to winemaking technology here goes back to ancient times. For example, a double-walled qvevri was found in Vardzia which served as a thermos. This is undoubtedly evidence that Georgian winemakers have been conducting research since prehistoric times and were the first in the world to determine the influence of such an important technological factor on wine quality as the temperature of alcoholic fermentation. In the ancient Kingdom of Colchis for the first time was found the method of wine production in anaerobic conditions under the pressure of carbon dioxide. This method is used to obtain non-oxidized wine, which is recognized as a natural product of the highest quality.

In the second half of the 20th century, technique and technologies for processing the secondary raw materials for winemaking were developed at the Georgian Scientific-Research Institute of Food Industry. In particular, a pomace extractor was manufactured for the processing of winemaking solid waste, a rational technology for the utilization of Prussian Blue was developed, etc. Unfortunately, nowadays this field is in an unfavorable position in terms of introducing science-intensive technologies into production. Beside the raw materials preparation and wine realization problems, acute and still not solved problem is utilization of secondary raw material resources. It is known, that as a result of grape industrial processing there remains the big amount of secondary raw material (wastes), which approximately represents the 10-20% of processed grape amount [3].

In Table 1 there are presented chemical compositions of extracts of Georgian industrial grape varieties' pomaces.

Table 1 Chemical composition of grape pomace extracts

Indicator	**Sample's title**		
	Rkatsiteli sweet pomace extract's free-run fraction	**Rkatsiteli sweet pomace extract's press fraction**	**Tsolikouri sweet pomace extract's free-run fraction**
Sugar, %	7.0	6.22	5.8
Titratable acidity, g/l	3.77	4.09	4.2
Tartaric acid, g/l	0.39	0.43	0.61
pH	3.77	3.55	3.55
Tannin, g/l	5.2	6.4	4.09
Sugar-free extract, g/l	23.87	24.4	17.88
Ashes, g/l	4.37	4.19	3.7
Total nitrogen, mg/l	142	237	166

The extracts were received through hot water extraction of freshly pressed pomace (ratio of extractant to solid phase 0.7:1). Analysis of the obtained results show, that pomace water extracts are enriched with biologically active substances and can be used for functional drinks, natural additives and other products production.

In Table 2 there are given quantitative amounts of compositional parts of non-fermented and fermented pomace.

Table 2 Grape pomace composition

Component	P Composition, %
Non-fermented pomace with stems, dried on the air	
Skins	50
Stems	25
Seeds	25
Fermented destemmed fresh pomace	
Skins	73
Stems	1
Seeds	23
Other parts	3

Crimean scientists (I. Ogai and I. Chernousova) have proposed a technology for preparing the food concentrate from the grape polyphenols for dietary use [4]: grape pomace is extracted using ethanol acidified with citric acid. The amount of citric acid in the extractant should not exceed the mass content of tartaric acid in the initial product. The resulting extract is concentrated under vacuum after separation. To the received concentrate is added invert sugar syrup. Given technology gives ability to keep the initial composition of grape polyphenols, that ensures the high biological and antioxidant activity in the resulting product even after long-term storage [5].

Grape skins are rich in biologically active substances and can be the source of food fiber [4]. It is known, that technology of production of food powders from grape pomace, which includes convectional drying with hot air (in terms of 75- 80˚C temperature), then pomace filtering in sieve in order to remove seeds and received mass mashing. The powder received with this way is recommended to be used in bread baking [6]. Powder received from grape pomace has much more high antioxidant activity than wheat powder.

In Italy from grape pomace – winemaking waste – there are producing Grappa (in the past Italian poor people's home-distilled vodka), which nowadays is considered as outstanding alcoholic drink.

The success of developed countries in the processing and utilization of winemaking waste is achieved through the implementation of state programs and the existence of a strong scientific and research base. Thus, in Italy, the National Institute of Grappa has been created, which has five branches in different cities of the country. For example, in the UK, one of the most prestigious institutions operates – the Specialized Institute of Masters of Wine. In Germany the German Institute of Winemaking (DWI) deals with viticulture and winemaking issues. Waste-free production is also being introduced in Bulgaria. In those regions, where mainly white grape varieties are grown, Bulgarian union “Vinprom” creates special utilizing factories, which are extracting sugar from sweet pomace, separating grape seeds and drying them. The extracted pomace is supplied to the enterprises of the agro-complex for animal feed. In regions where mainly red grapes are grown, complex processing of grape pomace is carried out to obtain dyes, food flour, and tartaric acid compounds [7].

Due to its high biological value, interest in winemaking secondary products grows worldwide every year. In Moldova, since 2004 there has been a state program for the processing and use of winemaking secondary products, which provides the funding of a number of scientific projects from the state budget. Last year, the budget allocated 1.2 million lei for this purpose [5].

In Georgia till now there don’t exist the winemaking wastes processing factories, or just districts, that shows the fact, that existing in the country plant raw material resources are being used uneconomically. For example, press fraction (pomace) remaining after the result of grape processing on average contains 24 g/kg grape polyphenols, that are strong antioxidants of plant origin. On world market 1 g polyphenols’ minimal price is 2 US dollars [8]. So that, every year after processing of 100 thousands of tons of grape loses polyphenols averagely more than 700 mln US dollars production. Another product to be paid attention to is also amivit – the only natural product, which is rich in B group vitamins and other high nutritive value components. This product is produced from grape wine dry yeasts.

Table 3 Products received by grape secondary materials processing

Secondary raw material	**Final product's title**	**New product received via secondary product application**	**Production outcome, %**	**Market price, US dollars**	**Income from realization, $/t**
1. Grape berries skins	Grape Paste (white, red)		70 % calculated on raw pomace	7/220 g	31818
	Enological dye		20 dals from 1 t paste	5/kg	1000
2. Seeds (3-4 % of processed grape)	Dry seeds (25 % calculated on dried on-air pomace	Tannin (enotannin)	0.31 – 5.56 % in average 2.94%	100 /kg	100000
		Grape oil	9.9 – 20.6 on average 15.25%	As food oil (2/0.1 L); as curative-prophylactic mean (10/0.1 L)	20000 100000
3. Stems (1-7 % of processed grape)	Tannin		3, 27 % calculated on raw pomace	100 /kg	100000 1 t calculated on raw pomace
	Vinegar		0.2 – 1.5% on average 0. 85%	0,5 /250 ml	
4. Yeasts Lees (2.5-6% of processed grape)	Lifestock food product				
	enant-ester aldehydes		0.04%		
	Lifestock protein food product		325 kg 100 dal on pressed yeasts		
	Raw alcohol		25 – 35% calculated on distilled wine		
	Rectified alcohol				
	Higher alcohols				
5. Pomace (10-14 % of processed grape)	Enological dye (dry powder)			5/kg	
	Pomace extract	Functional drinks	100% regarding pomace	2/L	2000 t
	Chacha vodka				
6. Remaining liquid part from wine (65 % of processed wine)	Alcohol free wine		60% of processed wine	5/L	5000 t

According to preliminary calculations, the profitability of the production of this vitamin concentrate is 70%. Production is much more efficient and requires material investments [9]. Thus, using the two indicators given above as an example, we can judge how much income the state loses due to the non-use of secondary raw materials in winemaking.

For a more accurate economic assessment of the efficiency of processing ther wine industry wastes existing in Georgia, table 3 shows the calculation of the efficiency of various industrial branches of secondary raw materials of wine industry. In particular, out of 250,000 tons of grapes, 20% of the raw material (grapes) remains as secondary raw materials, which in amount is amount 50,000 tons of valuable secondary raw materials that are simply thrown away and pollute the environment.

The data in Table 3 proves that winemaking wastes can be used for production of various types of products, the majority of which are demanded in the world market and have quite high prices. Based on the above, Georgia loses millions of GEL-s, because the existing secondary raw materials resources in the field are remaining unused. In this regard, targeted joint actions by the state, science, and industry are necessary. Unfortunately, nowadays the majority of Georgian factories practically do not show interest toward the increment of the efficiency of the raw materials use, this indicates that in the nearest future we should not wait the increment the competitiveness of the produced products, the meaningful increase of the country's export potential. In such circumstances, the state must take on the task of developing secondary raw materials through a public-private partnership mechanism, especially since a relevant law on public-private partnerships was adopted in 2018 for this purpose.

It should be underlined that expansion of public-private partnership application, a thoughtful approach and readiness at the highest levels of the state to implement the structural reforms and the immediate implementation of these reforms will allow us to confidently respond to the modern technological challenges and become a prerequisite for bringing the country to a fundamentally new level in the field of innovation. But this can only be achieved by ensuring the necessary level of economic freedom, creating equal conditions for competitiveness, the rule of law, as well as through the effective integration of government, science, education, and business.

As we have mentioned, at the Georgian Scientific-Research Institute of Food Industry there are undergoing the investigations aiming the elaboration of grape raw material complex and waste-free technology. For today there is elaborated the principally new technology of Georgian grape vodka – chacha's production, which gives the opportunity to improve the drink's organoleptic components and to increase safety, there are being developed the principally new technologies for wine liquid wastes application in order to receive alcohol-free antioxidant wine, there is elaborated grape origin natural dyes production technology and etc. Except these, in the institute there is recognized and being realized new direction of winemaking wastes processing technology, that means the production of biologically active products from winemaking wastes, the rentability of production of those is more than 100 %. To these products belong: concentrates enriched with polyphenols, low alcohol and alcohol-free drinks, curative-prophylactic functional products and many others [6,10].

It is important for Georgia to share the experience of foreign countries in the effective use of grape raw materials. Applying this experience, taking into account national characteristics, will allow us to produce competitive products, bring the beverages produced here and the profitability of their production closer to the indicators of the world's leading wine-producing countries. In particular, it is necessary to use the experience of the post-Soviet area. For example, in 2017, the European Union allocated funding to Ukraine and Moldova for the implementation of a grant project - EU No. 83263440 "Development of the Ukrainian-Moldovan cross-border industrial-scientific-educational cluster in the direction of processing secondary products of winemaking". The project is part of the Moldova-Ukraine Territorial Cooperation Program, which in its turn is included in the Eastern Partnership Territorial Cooperation Program (EaPTC). This project provides for the intensification of scientific, educational and organizational activities in order to attract the attention of the general public to solve the problem of complex processing of secondary raw materials in winemaking. In order to create the specialized institutions for the processing of secondary raw materials of winemaking in Ukraine and Moldova, it is envisaged to unite the potential of scientific institutions, winemaking enterprises, state and public structures on the basis of cluster ideology, which will allow us to receive additional income through the sale of products made from secondary raw materials. The formation and functioning of a cross-border cluster in the complex, waste-free direction of processing secondary raw materials for winemaking is an economically feasible, innovative and investment-attractive project that meets the commercial interests of all participants: these are representatives of founders, raw material suppliers (grape processing factories), scientists, producers and consumers of industrial products. The grant project is funded by the European Union through the German side's international cooperation (GIZ).

2. Conclusion

The Georgian Scientific-Research Institute of Food Industry has developed the technologies for the complex and sustainable use of grape raw materials, the implementation of which will move the Georgian winemaking industry to a higher level of quality. By introducing the waste-free technology, it is possible to obtain many new products necessary for other sectors of the national economy, increase the efficiency of winemaking enterprises and their export potential.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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