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K. B. Kobelev[1], A. V. Danilyan[1], A. N. Barykin[1], I. V. Selina[1], M. S. Sozinova[1], D. E. Nurmukhanbetova[2], Z. Zh. Seidakhmetova[2]

[1]All-Russian Scientific Research Institute of the Brewing,
Non-Alcoholic and Wine Industry – Branch of the V. M. Gorbatov Federal Research Center
for Food Systems of Russian Academy of Sciences, Moscow, Russia,
[2]NARXOZ university, Almaty, Kazakhstan.
E-mail: k.kobelev55@mail.ru; a.danilyan@mail.ru; audion@mail.ru;
solodarbitrag@bk.ru; dinar2080@mail.ru; s.zaure@bk.ru

PROSPECTS OF GRAPE MARC APPLICATION IN BREWING

Abstract. The paper presents studies results of practical aspects of dry grape marc use in brewing with humidity of 8.5%, obtained in laboratory on horizontal type dryer. In course of research work performed in laboratory, samples of unfiltered top-fermented beer were obtained, both without using and using dry grape marc. Finished beer was analyzed using standard methods, adopted in brewing, as well as using modern methods of high-performance liquid and gas chromatography for organic acids, carbohydrates and glycerin, volatile components, phenolic and furan compounds determination, that determine fermented drinks organoleptic profile. The potential of expanding special varieties range of brewing products with high consumer properties with the addition of raw material in the form of dry grape marc was revealed. Analysis of presented experimental data allows to conclude, that the technology of special beer sorts does not require additional production costs, since it can be carried out on existing production lines. The article makes assumptions about additional motivation of lean manufacturing system development in wine industry through grape marc use in brewing.

Key words: grape marc, special beer varieties, organoleptic profile, organic acids, sugars, glycerin, volatile components, phenolic and furan compounds.

Introduction. At the present stage of food market saturation with new food products, including alcoholic and non-alcoholic drinks, following areas should be highlighted:

- satisfaction (expansion) of consumer demand, taking into account product quality requirements [1-4].
- creation of new products and products with use of food components not previously used in them [5-8];
- accounting of food intake in the diet and at the same time in-depth study of basic technological processes influence on product quality, etc. [9, 10].

At the same time, it should be noted, that the development trend of new innovative technologies application in food production, based on use of secondary products [11].

Currently, wine industry has developed technological and production issues for wine waste processing and secondary winemaking products (SWP) production. This problem has not lost its relevance and finds new application aspects.

According to the experts of Russian National Research Institute of Viticulture and Winemaking "Magarach" of RAS, the use of secondary winemaking resources is of great importance both in terms of economic feasibility in obtaining a number of new and useful natural products for national economy needs, and to solve the problem of complex winemaking waste processing and safe disposal [12, 13].

The idea of grape marc use in brewing was formulated in works of N.I. Razuvaeva and Z.N. Kishkovsky in 80s of XX century, in which it was stated, that grape marcs freed from seeds could be used for grape beer production [14-16].

According to the works of A.O. Chursina data, grape marcs by their mass take largest part of the secondary raw materials of winemaking from 7 to 17% [12].

With average annual volume of processed grapes by winemakers in our country at the level of 540 thousand tons, there is reason to believe that grape marcs can become a full-fledged product, used in beer industry with additional technological processing.

Due to the currently insufficient use of secondary resources of wine industry processing enterprises, search for directions and ways of researching, developing and creating new products from secondary winemaking raw materials is of particular relevance.

Such direction could be the use of non-fermented grape marc as a raw material in special beer varieties and beer drinks production with high consumer properties.

The grape marc contains 1.2-3.6 % minerals of mass. Potassium and phosphorus predominate among the ash elements. Mass fraction of sugars in sweet grape juice ranges from 5 to 10%, tartrate compounds - 0.5 to 2.0%. At the same time, tartrate compounds mainly consist of free tartaric acid (40%) and potassium bitartrate (10-12%), as well as malic acid. In addition to the listed chemical compounds, marcs contain pentosans (1.0–4.5%), pectin (0.5–3.8%) and phenolic (up to 11%) substances. The extract from grape marcs isolated and identified lupeol, oleanolic acid, quercetin and glucoside b-sitosterol, as well as dietary fibers [17, 18].

Given the seasonality of obtaining sweet grape marc with humidity of at least 80%, it is necessary to process it by drying or extraction to preserve useful substances.

The use of dried grape marc or extracts from it will expand beer drinks and special beer varieties range.

Currently known beer varieties with use of grape juice, such as Italian grape ale, as well as drinks in the form of beer and grape juice mixes. Let us give some examples to illustrate the individual characteristics of such drinks.

In the description of the Italian grape ale (red and white), production of which uses different grape varieties, the following characteristics of drink aroma, color and taste are indicated:

- aroma with noticeable aromatic characteristics of a certain grape variety, but they should not overshadow other flavors. The malt character is usually restrained, and the hop character can vary from medium-low to absent.

- color from gold to dark brown. Ruby reddish color is usually due to red grapes use. Beer foam from white to reddish.

- many interpretations of taste are permissible. As in aroma, must be present grape character (resembling grape mash or wine), it can vary from delicate to medium-intensive. Grape varieties can affect taste sensations in different ways.

Typical ingredients of Italian grape ale:

The base is light malt or pils with a small amount of special malts or unmalted raw materials. Grape can be up to 40% of milled. Grape or wine mash (sometimes additionally boiled) can be used at various stages - during cooking, primary/secondary fermentation or aging. Ale or wine yeast may produce neutral character (more common) or fruit profile (English and Belgian strains). A wide range of hop varieties can be used, but in small quantities, so as not to give the beer an excessive character [19].

Experimental beer drinks made with grape juice addition have widest distribution geography - from European countries to China, including Russia. According to Czech Republic specialist's opinion, due to fresh grape juice added to beer, it acquires a reddish tint and has refreshing taste and pleasant sourness [20].

Research methods. The main organoleptic and physicochemical indicators of unfiltered beer using grape marc were made according to GOST 31711-2012. The mass concentration of organic acids was determined according to GOST 33410-2015. The mass concentration of sugars and glycerol was determined according to GOST 33409. The mass concentration of volatile components was determined according to GOST R 57893-2017. Determination of phenolic and furan compounds was carried out according to GOST 33407-2015.

Research results. To study grape marc influence on quality of finished beer in brewing technology department of All-Russian Scientific Research Institute of Brewing, Non-Alcoholic and Wine Industry at the BRUMAS (Germany) micro-brewery, samples of control and experimental beer were prepared using

grape marc from Moldova grapes variety. The original grape marc was pre-dried at a temperature of 60-80 °C for 12 hours on a horizontal dryer to a moisture content of 8.5%. Dried marc was made by mashing malted barley malt with water in infusion method in amount of 20% by weight of mashed malt. The hopped 11% wort was fermented with use of dry, pure culture of top-fermenting yeast of race S-04 (France). After ripening, finished unfiltered beer was analyzed by standard methods. Results are presented in table 1.

Table 1 – Organoleptic and physicochemical indicators of control and experimental unfiltered beer with use of grape marc

Indicator name	Control sample	Experimental sample with use of grape marc
Transparency	nontransparent foaming liquid without foreign inclusions not inherent in beer	nontransparent foaming liquid without foreign inclusions not inherent in beer
Aroma	Fermented malt, with yeast-flavored hop aroma	Fermented malt, with yeast-flavored hop aroma and grape aroma
Taste	Fermented malt, with hop bitterness, yeast flavor	Fermented malt, with hop bitterness, yeast flavor and wine tones
Volume fraction of alcohol, %	4,4	4,9
Acidity, a.u.	2,3	2,5
pH	4,0	4,2
Color, c.u.	2,0	2,4 (with reddish tint)

Finished beer analysis allows to conclude, that researched beer samples corresponded to requirements of current standards for main organoleptic and physicochemical parameters.

Currently, additional research methods are used to identify and assess the quality of brewing products, such as organic acids content, differential sugars composition, glycerin, volatile components, phenolic and furan compounds, that have significant effect on organoleptic fermentation product. In this regard, prepared beer samples were analyzed by above indicators (tables 2–5).

Table 2 – Organic acids mass concentration in control and experimental samples of unfiltered beer

Organic acid	Organic acids mass concentration, g/dm^3	
	Control Sample	Experimental sample with use of grape marc
Oxalic	0,1	0,2
Tartaric	0,3	0,9
Malic	0,4	0,4
Lactic	0,6	0,5
Citric	0,8	0,6
Succinic	0,4	0,8

Obtained experimental data indicate, that in unfiltered beer samples under study, the range of organic acids is identical. In unfiltered beer using grape marc, the content of oxalic, tartaric and succinic acids is 2-3 times higher than level of their content in control sample.

Table 3 – Sugars and glycerin mass concentration in control and experimental samples of unfiltered beer

Sugars and glycerin	Sugars and glycerin mass concentration, g/dm^3	
	Control Sample	Experimental sample with use of grape marc
Glycerin	2,6	2,8
Fructose	–	0,9
Glucose	1,1	0,7
Maltose	1,0	0,5

The data, presented in table 3 shows, that content of glycerin formed in the process of wort fermentation is almost at the same level. The content of fructose in control sample is absent, and the content of glucose and maltose is 1.5-2.0 times higher than in experimental sample. The fructose content in experimental beer sample can be explained by its presence in original grape marc.

Table 4 – Volatile components mass concentration in control and experimental samples of unfiltered beer

Volatile components name	Volatile components mass concentration, mg/dm^3	
	Control sample	Experimental sample with use of grape marc
Acetaldehyde	24,5	54,3
Formosol	1,0	1,3
ethyl acetate	6,9	8,0
2-propanol	0,3	0,4
Diacetyl	0,1	0,4
2-butanol	1,9	3,8
Isobutanol	6,6	19,0
Isoamyl acetate	0,2	0,4
1-butanol	0,1	0,2
Isoamilol	33,1	61,6
Phenethyl alcohol	11,9	29,2

It should be noted, that the volatile components nomenclature, presented in Table 4 is characteristic for beer and fermented drinks. However, in experimental beer sample, obtained using grape marc, an increased content of acetaldehyde, ethyl acetate, diacetyl, 2-butanol, isobutanol, isoamylol, and phenylethyl alcohol is typical, which is typical to grape-based fermented drinks.

Table 5 – Phenolic and furan compounds determination in control and experimental samples of unfiltered beer

Phenolic and furan compounds	Phenolic and furan compounds mass concentration, mg/dm^3	
	Control sample	Experimental sample with use of grape marc
Gallic acid	0,9	3,3
5- hydroxymethylfurfural	–	1,2
Furfural	0,5	3,7
Vanillic acid	2,2	3,3
5- methylfurfural	0,6	–
Syringic acid	0,9	7,0
Vanillin	0,4	0,4
Syringic aldehyde	–	0,2
Sinapic acid	0,6	0,7
Coniferyl aldehyde	0,3	0,5

Obtained experimental data on phenolic and furan compounds content in studied samples of unfiltered beer indicate, that there is no content in the control sample 5-hydroxymethylfurfurol, as well as syringic aldehyde.

No content of 5-methylfurfural was detected in experimental beer sample. At the same time, it noted an increased, compared with control sample, content of gallic acid, furfural and syringic acid. In our opinion, this is due to fermentation of extract from dried grape juice with top yeast during drink production.

Analysis of presented experimental data allows to conclude, that use of dried grape marc in brewing allows to expand the range of finished products with original organoleptic properties.

However, in connection with the adoption of Eurasian Economic Union Technical Regulations "On safety of alcoholic products" (EAEU TR 047/2018), these beers can be classified as special beer or beer drinks. The list of raw materials standards for these products will need to take into account the use of grape marc, as well as develop on them all the necessary regulatory documentation. Currently, studies are underway on grape marc drying modes selection for calculating the cost of its production.

Production technology of special beer varieties and beer drinks based on grape marc does not require additional production costs, since it can be carried out on existing production lines.

Organization of such production in traditional winemaking regions of Russia will ensure demand growth for grape marc as secondary winemaking product and will be additional motive for application of lean production management system at enterprises.

К. В. Кобелев[1], А. В. Данилян[1], А. Н. Барыкин[1], И. В. Селина[1], М. С. Созинова[1], Д. Е. Нурмуханбетова[2], З. Ж. Сейдахметова[2]

[1]Бүкілресейлік сыра қайнату, алкогольсіз және шарап өнеркәсібі ғылыми-зерттеу институты – ФМБҒМ филиалы В. М. Горбатов атындағы «Азық-түлік өнімдерінің федералдық ғылыми орталығы» РҒА, Мәскеу, Ресей,
[2]НАРХОЗ университеті, Алматы, Қазақстан

СЫРА ҚАЙНАТУДА ЖҮЗІМ СЫҒЫНДЫСЫН ҚОЛДАНУДЫҢ БОЛАШАҒЫ

Аннотация. Жұмыста зертханалық жағдайда көлденең түрдегі кептіргіште алынған ылғалдылығы 8,5% құрғақ жүзім сығындысын сыра қайнату кезінде қолданудың тәжіриебелік аспектілерін зерттеудің нәтижелері келтірілген. Зертханада жағдайында жүргізілген ғылыми-зерттеу жұмыстарының барысында жоғарғы ашыту кезінде құрғақ жүзім сығындысы қосылған және қосылмаған сүзілмеген сыра үлгілері алынды. Дайын сыра оны қайнату кезінде қабылданған стандартты әдістермен талданады, сондай-ақ ферменттелген суындардың органолептикалық көрсеткіштерін анықтайтын, органикалық қышқылдарды, көмірсуларды және глицеринді, ұшқыш қосылыстарды, фенол және фуран қосылыстарын анықтау үшін жоғары сапалы сұйық және газ хроматографиясының заманауи әдістері қолданылды. Құрғақ жүзім сығындысы түріндегі шикізатты қосып, жоғары тұтынушылық қасиеттері бар сыра қайнату өнімдерінің арнайы сұрыптарын кеңейту потенциалы анықталды. Ұсынылған тәжіриебелік деректерді талдау арнайы сыра сұрыптарының технологиясы қосымша өндірістік шығындарды қажет етпейді, себебі оны қолданыстағы өндіріс желілерінде жүзеге асыруға болады. Мақалада жүзім сығындысын сыра қайнатуда қолдану есебінен шарап өнеркәсібінде үнемді өндіріс жүйесін дамытудың қосымша мотивациясы туралы болжамдар жасайды.

Түйін сөздер: жүзім сығындысы, сыраның арнайы сұрыпы, органолептикалық профиль, органикалық қышқылдар, қант, глицерин, ұшқыш қосылыстар, фенол және фуран қосылыстары.

К. В. Кобелев[1], А. В. Данилян[1], А. Н. Барыкин[1], И. В. Селина[1], М. С. Созинова[1], Д. Е. Нурмуханбетова[2], З. Ж. Сейдахметова[2]

[1]Всероссийского научно-исследовательского института пивоваренной, безалкогольной и винодельческой промышленности – филиала Федерального государственного бюджетного научного учреждения «Федеральный научный центр пищевых систем им. В. М. Горбатова» РАН, Москва, Россия,
[2]Университет НАРХОЗ, Алматы, Казахстан

ПЕРСПЕКТИВЫ ПРИМЕНЕНИЯ ВИНОГРАДНОЙ ВЫЖИМКИ В ПИВОВАРЕНИИ

Аннотация. В работе представлены результаты исследований практических аспектов применения сухой виноградной выжимки в пивоварении с влажностью 8,5%, полученной в лабораторных условиях на сушилке горизонтального типа. В ходе выполненных научно-исследовательских работ в лабораторных условиях были получены образцы нефильтрованного пива верхового брожения как без использования, так и с использованием сухой виноградной выжимки. Готовое пиво анализировали стандартными методами, принятыми в пивоварении, а также с использованием современных методов высокоэффективной жидкостной и газовой хроматографии для определение органических кислот, углеводов и глицерина, летучих компонентов, фенольных и фурановых соединений, определяющих органолептический профиль напитков брожения. Выявлен

потенциал расширения ассортимента специальных сортов пивоваренной продукции с высокими потребительскими свойствами с добавлением несоложеного сырья в виде сухих виноградных выжимок. Анализ представленных экспериментальных данных позволяет сделать вывод о том, что технология специальных сортов пива не требует дополнительных производственных издержек, поскольку ее можно осуществлять на действующих технологических линиях. В статье выдвинуты предположения о дополнительной мотивации развития системы бережливого производства в винодельческой промышленности за счет использования виноградной выжимки в пивоварении.

Ключевые слова: виноградная выжимка, специальные сорта пива, органолептический профиль, органические кислоты, сахара, глицерин, летучие компоненты, фенольные и фурановые соединения.

Information about authors:

Kobelev K. V., Deputy Director for Science, Doctor of Technical Science, All-Russian Scientific Research Institute of the Brewing, Non-Alcoholic and Wine Industry – Branch of the V. M. Gorbatov Federal Research Center for Food Systems of Russian Academy of Sciences, Moscow, Russia; k.kobelev55@mail.ru; https://orcid.org/0000-0002-3619-6282

Danilyan A. V., Head of the Laboratory of Arbitration Analyzes and Quality Control of Brewing Raw Materials and Products, Candidate of Technical Science, All-Russian Scientific Research Institute of the Brewing, Non-Alcoholic and Wine Industry – Branch of the V. M. Gorbatov Federal Research Center for Food Systems of Russian Academy of Sciences, Moscow, Russia; a.danilyan@mail.ru; https://orcid.org/0000-0003-3943-9187

Barykin A. N., Researcher, Candidate of Economical Science, All-Russian Scientific Research Institute of the Brewing, Non-Alcoholic and Wine Industry – Branch of the V. M. Gorbatov Federal Research Center for Food Systems of Russian Academy of Sciences, Moscow, Russia; audion@mail.ru; https://orcid.org/0000-0002-4051-7392

Selina I. V., Senior Researcher of the Laboratory of Arbitration Analyzes and Quality Control of Brewing Raw Materials and Products, All-Russian Scientific Research Institute of the Brewing, Non-Alcoholic and Wine Industry – Branch of the V. M. Gorbatov Federal Research Center for Food Systems of Russian Academy of Sciences, Moscow, Russia; solodarbitrag@bk.ru; https://orcid.org/0000-0002-2361-019X

Sozinova M. S., Senior Researcher of the Laboratory of Arbitration Analyzes and Quality Control of Brewing Raw Materials and Products, All-Russian Scientific Research Institute of the Brewing, Non-Alcoholic and Wine Industry – Branch of the V. M. Gorbatov Federal Research Center for Food Systems of Russian Academy of Sciences, Moscow, Russia; solodarbitrag@bk.ru; https://orcid.org/0000-0002-8832-3394

Nurmukhanbetova Dinara Erikovna, candidate of engineering sciences, acting associate professor, NARXOZ university, Department of Food safety and quality; dinar2080@mail.ru; https://orcid.org/0000-0002-8939-6325

Seidakhmetova Zaure Zhunusovna, doctor of biological sciences, professor, Almaty technological university, Department of Food Biotechnology; s.zaure@bk.ru; https://orcid.org/0000-0002-9213-7391

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