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ENRICHMENT OF FUNCTIONAL DRINKS USING GRAPE POMACE EXTRACTS, ANALYSIS OF PHYSICOCHEMICAL INDICATORS

Hasil Fataliyev
Doctor of Technical Sciences, Professor*
Natavan Gadimova
Corresponding author
Candidate of Technical Sciences, Associate Professor
Department of Engineering and Applied Sciences
Department of Food Engineering
Azerbaijan State University of Economics (UNEC)
Istiqlaliyyat ave., 6, Baku, Azerbaijan, AZ 1001
E-mail: natavan.qadimova@mail.ru
Shafiga Huseynova
Assistant*
Simuzar Isgandarova
Assistant
Department of Chemistry**
Elnur Heydarov
Candidate of Technical Sciences, Associate Professor
Department of Food Engineering and Expertise
Azerbaijan Technological University (ATU)
Shah Ismayil Khatai ave., 103, Ganja, Azerbaijan, AZ 2011
Sevda Mammadova
PhD, Senior Lecturer*
*Department of Food Engineering and Expertise**
**Azerbaijan State Agricultural University (ASAU)
Ataturk ave., 450, Ganja, Azerbaijan, AZ 2000

A large amount of residues called secondary raw materials are formed during grape processing, the majority of which are pomace-containing seeds. Pomace is obtained by crushing grapes with subsequent juice separation and appears as a mass consisting of skin, seeds, as well as stalk and comb residues. When compared to the control, the amount of skin in the fermented pomace increased 15 %, while the amount of seeds decreased by about 50 %.

The objects of research is juice, wine materials, functional drinks, technological methods and means.

The problem is that the samples of juice and dark wine prepared by the "White method" are not provided with a sufficient amount of extract substances, especially compounds that provide functionality. The results of the experiment show that adding 25–30 % wine-alcohol extract of marc to the wine material obtained by the "white method" from the Bayanshira grape variety, and adding 25–30 % alcohol-juice extract to the juice obtained from its own stream, give a positive result. Compared to the control, in the prepared functional wine samples the content of phenolic compounds increased by 100 mg/dm^3, and there was also an increase in the amount of vitamins B_2, C, PP, B_6 and resveratrol.

Rational technological parameters for the extraction of biologically active substances from grapes and their structural components have been established. It has been established that mixing fermented pomace with a 30 % wine-alcohol (juice-alcohol or aqueous-alcohol solution) extractant in a 1:3 hydromodule gives the best result.

It is of practical importance to enrich low-extracted juices and wines with extracts obtained from the solid parts of the cluster to produce functional drinks

Keywords: grape pomace extracts, white method, red method, solid parts of clay

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1. Introduction

Approximately 20 % of the residues (stems, combs) formed during grape processing constitute a significant portion of the total production. Because of their richness in composition, those residues are referred to as secondary raw materials. Pomace is a 7.0–17.0 % residue separated from juice (sweet mash) or wine (fermented mash), accounting for the majority of secondary products formed during grape processing. It consists of skin, seeds, residual liquid (juice, wine), and sometimes comb residues. Depending on the applied technology pomace can be sweet (fresh, unfermented) – obtained from fresh grapes after pressing, and unsweetened (fermented) – obtained after pressing fermented mash (or stored and fermented). The ratio of the components of pomace can vary depending on the variety of grapes, the growing conditions, and the equipment used for pressing.

Millions of US dollars are lost every year due to polyphenols alone, which are lost in residues during grape processing. Dietary fibers and extracts obtained from residues are rich in biologically active substances and can be used as food additives. However, due to the lack of cost-effective and accessible technologies suitable for local conditions, thousands of tons of pomace and combs are discarded unused every year. Sometimes those residues are dumped near the processing facilities, polluting the environment and creating unsanitary conditions. One of the simplest ways to reuse residues can be the production of functional beverages from their extracts. As it is known, juices and white strong wines produced from white grape varieties have low biological value due to the small amount of polyphenols in their content. Eliminating the noted deficiency of this type of drink, which is in high demand by consumers, with the use of extracts obtained from grape pomace, is relevant and has scientific and practical importance.

2. Literature review and problem statement

Wine production worldwide produces enormous amounts of waste, such as grape pomace, consisting of skins, seeds and stems, leading to serious environmental problems. Due to their rich chemical composition, they were mainly used to produce wine alcohol, food coloring and grape seed oil, and also as animal feed or fertilizer. Pomace is rich in phenolic compounds, which have a beneficial effect on human health and, due to their biological activity, can be used as food additives and functional ingredients. One of the simplest ways to reuse residues can be the use of extracts obtained from them in the production of functional beverages. This is beneficial both from an ecological and an economic point of view.

Traditional solvent extraction methods have a number of disadvantages: compounds are lost during hydrolysis and oxidation, extraction is time-consuming, and organic solvents are used, which pollute the environment.

There are studies [1] on the extraction of dried grape pomace with acidified water and alternative methods, such as OAE and MAE, instead of organic solvents (they are toxic). The obtained results testify to the good quality of acidified water extracts of skin extracts from the point of view of the content of polyphenols, organic acids and minerals, and also reduce time and energy costs. Different drying methods were used for drying grape pomace: in an oven at a temperature of 50 °C for 48 hours, natural drying at room temperature for 72 hours and lyophilization for 48 hours. For objective reasons, it is possible to choose the method of drying grape pomace in the oven at a temperature of 50 °C, it is cheaper, faster and more reliable than drying in air at room temperature (only 48 hours versus 72 hours).

Extraction should be carried out at moderate temperatures, as well as controlled atmospheric conditions and the absence of light, to ensure good yield while maintaining biological activity.

Extracts of grape marc (Vitis vinifera) were obtained in supercritical fluids, instead of liquid solvents [2]. Extractions with liquid solvents have limitations: high energy costs, increased use of solvents, high temperatures, which are detrimental to heat-labile substances, low selectivity and solvent residues in the dissolved substance. The study showed that supercritical fluid extraction is effective in producing grape pomace extracts with good recovery of antimicrobial active compounds.

Dried grape marc is mainly used to produce wine alcohol or compost. In studies [3], an alcoholic extract from dried grape marc was used to enrich dried grape must and produce a new type of macerated wine. Increasing the content of phenolic compounds in wine improves functional quality.

There are studies [4] on the extraction of phenolic compounds from Cannonau grape pomace using pressurized liquid extraction (PLE), compared with traditional solid-liquid extraction. Solid-liquid extraction uses a large number of solvents, in some cases of an organic nature, which is not beneficial from an environmental point of view. This experimental model is an alternative method for extracting bioactive substances from grape pomace.

Studies have been conducted [5] to evaluate green solvents (two alcohols (EtOH and 2-Prop), three ethers (2-MeTHF, CPME and DMI), three esters (EA, EL and DMC), one terpene (LIM) for the extraction of phenolic compounds from white grape waste Long extraction time increases energy costs, reduces extraction yield and is not economically profitable from this point of view, the terpene LIM solvent was not studied in subsequent analyses. The results showed that EtOH and 2-MeTHF solvents were the most effective in terms of total phenolic compounds and total flavonoids extracted, as well as the high antioxidant capacity of the extracts.

Membrane processes have now been used to separate, purify and concentrate polyphenols from agricultural by-products. They are low-cost, simple, highly selective in separation and guarantee the best quality of extracts [6]. The extraction of phenolic compounds from red wine lees through a combination of microwave extraction and membrane separation processes has been investigated [7].

Alpha glucosidases play a significant role in the digestion and absorption of carbohydrates. The antidiabetic potential of red wine pomace Chambourcin, Merlot, Norton, Petit Verdot, Syrah and Tinta Can was studied by assessing their alpha-glucosidase inhibitory activity [8]. Extracts of Tinta Kao, Syrah and Merlot showed higher effectiveness in inhibiting α-glucosidase. This is explained by the higher content of phenols compared to another pomace. Therefore, the red wine marc of Chambourcin, Norton and Petit Verdot remained unexplored. Tinta Kao red grape marc is recommended for use as a dietary α-glucosidase inhibitor for the prevention and treatment of diabetes.

The use of pomace obtained from the processing of Isabella and Bayanshira grapes in the production of functional yogurt has been studied [9]. During the research, it turned out that extracts obtained from the Isabella grape variety have a richer composition and a particularly strong muscat aroma than Bayanshira. For these objective reasons, extracts obtained from Bayanshir grapes were not studied in further experiments. It has been established that the addition of Isabella grape marc powder leads to a decrease in the content of free radicals in yogurt, an increase in the amount of dietary fiber and phenolic compounds, and the resulting product differs in functionality, dietary properties and aroma.

As it can be seen, researches on the use of pomace extracts in the production of various food products are given ample space in the conducted researches. Although the conducted research has produced important results in this field, it has not been able to provide a fundamental solution to the issue.

Extracts are a source of polyphenols, organic acids and can be used in the production of functional beverages. As it is known, juices and white dark wines obtained from white varieties of grapes have a low biological value due to the small amount of polyphenols in their composition. The noted deficiency of this type of drink, which is in high demand among consumers, should be eliminated by using extracts from grape pomace obtained from the grape varieties Krasny-Merlot, Madras and Isabella, Bayanshira and Rkasiteli.

3. The aim and objectives of the study

The aim of the study is to improve the technology of functional drinks using the juice formed during the processing of grapes. The developed technological methods will significantly increase the quality, nutritional value, organoleptic characteristics of the finished product, this will allow them to be used in the production of beverages.

To achieve this aim, the following objectives are accomplished:

– select and conduct a comparative assessment of extractants for better extraction of substances from the solid parts of berries;

– investigating the preparation of wine using extracts from grape pressing;

– study the preparation of juice-containing drinks using extracts from grape pressings.

4. Materials and methods of research

The objects of research are juices, wine materials, and drinks. For the study, pomace was selected from red grape varieties Merlot, Madras and white grape varieties Bayanshira and Rkatsiteli, which are considered suitable for obtaining extracts with a high content of extracts.

The skin, seed, comb, and stem residues included in the composition of pomace were rich in functional polyphenols, vitamins, minerals, and other nutrients. Samples of pomace obtained from a mixture of grape varieties processed in three variants are used. No. 1 – Rkasiteli+-Bayanshira (pomace obtained by the "white method"); No. 2 – Madrasa+Merlot (sweet pomace obtained after 24 hours of mash maceration); No. 3 – Madrasa+Merlot (sour wine obtained by the "red method"). Water, alcohol, juice, wine, and their mixtures in different proportions and extraction modes and modules of pomace with solid fraction were used to extract substances from pomace components. The extraction of phenolic compounds from pomace is mainly carried out using four extractants: 2 % tartaric acid, 25–30 % v/v alcoholized sour wine, 25–30 % v/v juice and 25–30 % v/v water. The extraction process was carried out in a fermented pomace. Fermentation of the pomace was carried out for 7 days following the current methodology, by spreading the pomace with a thickness of 4–5 cm in open sunny weather and turning it 3–4 times every day. Using the obtained extracts, various types of functional-purpose drinks were prepared and studied. The determination of the main components of the chemical composition was performed according to the existing standard methodologies and modern analysis methods [10].

Taking into account that some of the used extractants can affect the amount of acids, research is continued by changing the extractants containing acid, juice, and wine (in short, containing acid) with new ones. For this purpose, water with a temperature of 65–75 °C; A water-alcohol mixture of 65–75 % v/v and ordinary water with a temperature of 18–22 °C are used.

The research and comparative evaluation of the production of various functional wines and juices using the best pomace extracts selected experimentally were carried out.

Statistical analyses were performed using the SPSS18 package [11].

5. Results of improving the technology of functional beverages using the juice formed during grape processing

5. 1. Comparative evaluation and selection of extractants for better extraction of substances from solid parts of clay

The composition and yield of grape pomace are determined by the grape processing method, varietal characteristics, and pressing quality. Cells obtained from grape varieties used in the study were fermented separately and the average composition was determined. The skin was discovered to be the most important component of the fermented pomace samples (84.9–86.7 %). Then comes the seed, which ranged from 11.6 to 13.5 %, and comb scraps in pomace ranged from 1.5 to 1.7 % depending on the variety. The pomace structural parts mentioned above are extremely rich in functional nutritional elements. Aside from scientific and practical significance, their return to reproduction has significant economic benefits. Pomace samples obtained from a mixture of grape varieties processed according to three options were used. No. 1 – Rkasiteli+Bayanshira (pomace obtained by the "white method"); No. 2 – Madrasa+Merlot (sweet pomace after 24 hours of mash maceration); No. 3 – Madrasa+Merlot (sour wine obtained by the "red method"). 2 % tartaric acid, 25–30 % v/v alcoholized sour wine, 25–30 % v/v alcohol-juice, and 25–30 % v/v alcohol-water were used for the extraction of phenolic compounds from pomace. The extraction process was carried out using fermented pomace. The results obtained show that less separation of phenolic compounds occurred when a 2 % tartaric acid solution was used (Fig. 1).

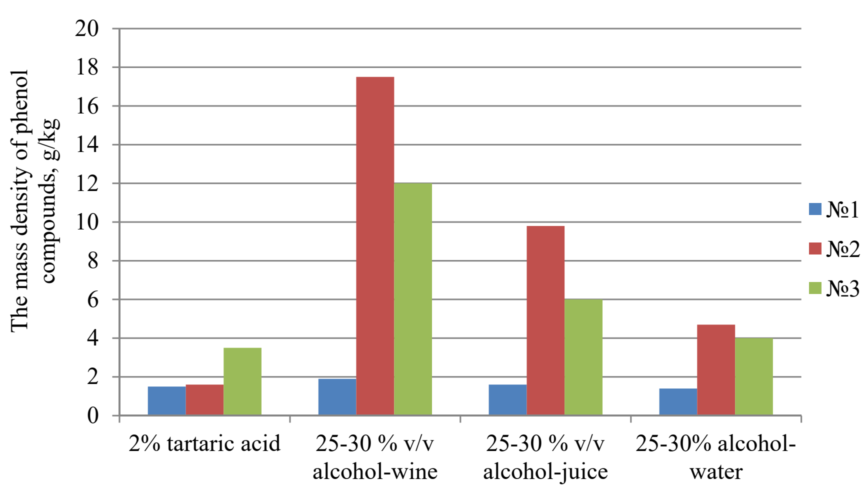

Fig. 1. Amount of total phenolic compounds in pomace extracts obtained with different extractants, n=6, p<0.05

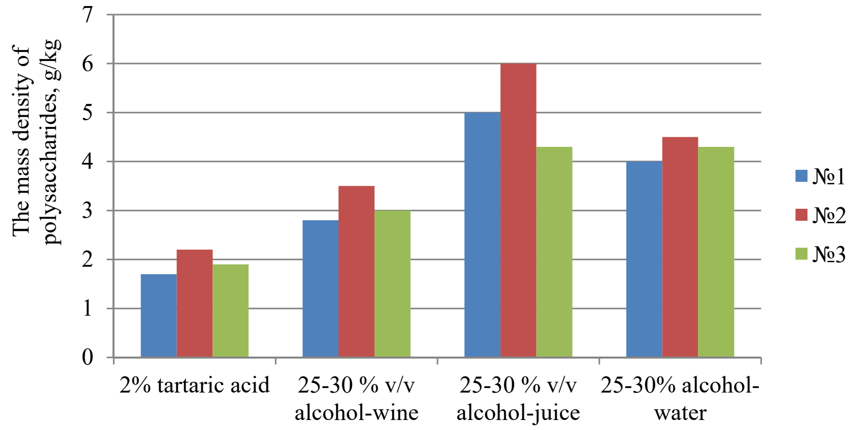

Fig. 2. Changes in the polysaccharide quantities of the extracts, n=6, p<0.05

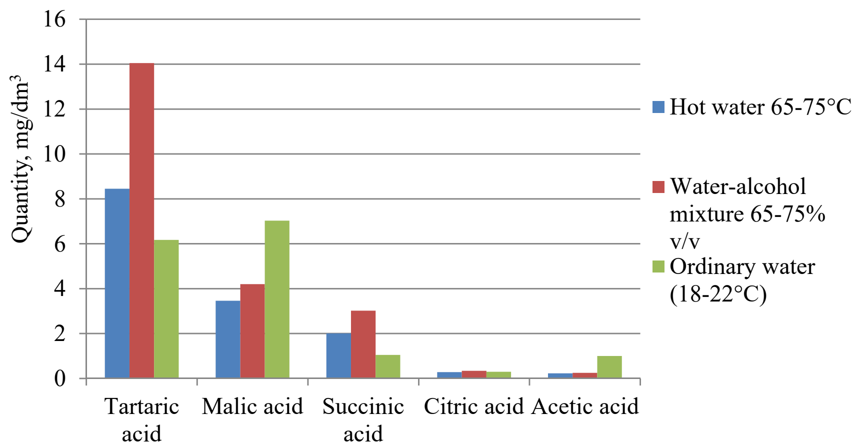

Fig. 3. The amount of organic acids in pomace samples treated with different extractants, n=6, p<0.05

As seen, when 25–30 % v/v wine-alcohol extractant was used, the best results were obtained for both variants II and III, and maximum values of phenolic compounds were provided in these options.

When 25–30 wt% alcoholized juice was used, the high amount of phenolic compounds according to the II option was noticed and this amount was 9.7 g/kg. In option III, this indicator was 6.1, and in option I, compared to other options, it was the least, i. e. 1.5 g/kg.

When 25–30 % alcohol-water mixture extractant was used, a similar pattern was observed, but in this case the values were less than 5.

Grape skin polysaccharides are represented by water-soluble polysaccharides, starch, pectin substances, hemicellulose, cellulose, and other high molecular carbohydrates. These substances form the skeleton of the skin. By determining the polysaccharides in the extracts, it is possibel to conclude that they were obtained in greater quantities when 25–30 % alcoholized juice was used (Fig. 2). In this case, the main increase was observed in the I and II variants. When other extractants were used, the II and III variants outperformed the others, and the amount of polysaccharides was represented by smaller indicators than in the previous ones.

As is known, organic acids and their quantity are important quality indicators of any food product. During the processing of grapes, most of the organic acids pass from the skin to the juice. The rest is stored in the cells in the deeper layers of the skin. The correct selection of the extractant is critical for determining the amount of tartaric acid in the extracts. Since the previous extractants affected the amount of acids, it is possible to continue the research by changing the extractants. Let's use hot water with a temperature of 65–75 °C; 65–75 % v/v water-alcohol mixture and three extractants with a temperature of 18–22 °C (Fig. 3).

As it can be seen, tartaric acid was more in variants I and II, malic acid in variants II and III, and succinic acid in variants I and II. Another noteworthy point is that the amount of malic and acetic acids reaches a maximum in variant III.

Alkali and alkaline-earth metal cations are important components of pomace. Although they are classified as biologically active substances, when pomace is used for the production of dietary fiber, they are considered a ballast mixture. By interacting with potassium and calcium acids, they form slightly or completely insoluble salts. As a result, the extraction process (or the cleaning of the pomace) becomes difficult. From this point of view, the safety indicators of food fibers obtained from grape pomace were studied. It was found that the amount of toxic elements, mycotoxins, and organochlorine pesticides in food fibers was much lower than the maximum permissible level.

5. 2. Study of wine preparation with the application of ceca extracts

It is known that the equipment and lines available in the production are not always capable of ensuring the extraction of wine material. In order for juice and wine material to be in contact with solid parts for a long time, a large number of equipment and technological vessels, as well as production areas, are required. In this regard, the enrichment of low-extract juice and wine with extracts obtained from the solid parts of the cluster is very relevant and promising. Therefore, the production of wines with improved quality by the application of extracts was studied.

In order to produce wines of improved quality using extracts, 3, 5, and 7 % extracts were added to the juice and wine material obtained by the "white method" from the Bayanshira grape variety. Antioxidant capacity, mass fraction of phenolic compounds, mass concentrations of resveratrol, vitamins, and amino acids were determined in the finished drink, and the samples were evaluated by the organoleptic method. A sample of wine without extract was taken as a control (Table 1).

As seen, the addition of extracts did not fundamentally affect the amount of sugar, only as the amount of added extract increased, the sugar content decreased by 0.1 %, and the alcohol content increased by 0.1–0.2 %. Such a decrease can be attributed to an increase, although very small, in the volume of added extract. The increase in the amount of alcohol was due to the high darkness of the added extract. Compared to the control, the amount of titratable acids was 0.03–0.08 g/dm^3 in experimental samples, and the amount of derived extract was 0.05–0.10 g/dm^3.

Table 1

Physicochemical indicators of wine samples prepared with the addition of extract, n=6, p<0.05

Indicators	Variants			
	Control	Juice with 3 % extract added	Juice with 5 % extract added	Juice with 7 % extract added
Sugar, %	9.8	9.8	9.7	9.7
Alcohol, % v/v	16.5	16.5	16.6	16.7
Titratable acid, g/dm^3	6.52	6.55	6.58	6.60
Mass proportion of phenolic compounds, (converted to folic acid) mg/dm^3	170.4	230.0	270	290.8
Mass proportion of resveretrol, mg/dm^3	–	8.5	18.6	21.3
Antioxidant capacity, mkmol trolox equiv/dm^3	308.6	520.5	766.0	850.1
Derived extract g/dm^3	21.40	21.45	21.48	21.50
Degustation score (points)	7.55	7.80	7.90	7.85

The amount of phenolic compounds in the experimental variants was significantly higher than in the control. Thus, this parameter was 170.4 mg/dm^3, while it was 230 mg/dm^3 and 270 mg/dm^3 when 3 % and 5 % extracts were added, respectively. Accordingly, an increase in resveratrol and antioxidant capacity was also observed in experimental samples.

During the organoleptic evaluation of the samples, the wine sample with 5 % extract scored 0.35 points higher than the control sample (7.90 points). The increase in extract concentration above 5 % had a negative effect on the organoleptic quality of the drink, resulting in a 0.05 point lower evaluation than the previous sample.

One of the sensitive points in the process of making a drink with the addition of an extract is the change in the amount of vitamins in the drink (Fig. 4).

As seen, an increase in the amount of vitamins was observed in all experimental samples obtained with the addition of the extract. As the amount of extracts increased, a greater increase was observed in the amount of vitamins B_2 and C (7.7–7.8 mg/dm^3), relatively less in the amount of PP and vitamin B_6 (1.4–1.6 mg/dm^3). Even the options with the least growth can be evaluated as significant growth in comparison. Regarding the role of the mentioned vitamins in the human body, it can be noted that group B vitamins are useful in normalizing the work of the cardiovascular system, while nicotinic acid and vitamin C are useful for their strong antioxidant effect.

Quantitative and qualitative analysis of the content of amino acids in the studied drink samples was carried out (Table 2).

The addition of extract to the white dark wine material apparently resulted in significant changes in the quality and quantity of amino acids. As the dose of the extract was enhanced, the amount of amino acids increased in almost all samples. This was only weakly visible in the amounts of histidine, proline, and phenylalanine.

Table 2

Effect of the added extract on the amino acid content of the wine material, n=6, p<0.05

Mass concentration of amino acids, mg/dm^3	The amount of extract added to the drink, %			
	Control (without addition)	3	5	7
Asparagine	202	430	575	636
Tryptophan	290	320	376	445
Serine	460	930	1145	1376
Glutenin	665	1103	1296	1430
Glycine	219	530	665	804
Alanine	250	375	450	497
Cysteine	60	185	275	280
Valin	170	280	310	370
Methionine	38	160	200	220
Isoleucine	260	380	445	490
Leucine	480	596	620	660
Tyrosine	240	330	371	404
Phenylalanine	230	250	256	270
Histidine	570	581	580	582
Lysine	200	540	635	810
Arginine	544	716	733	794
Proline	930	944	950	950

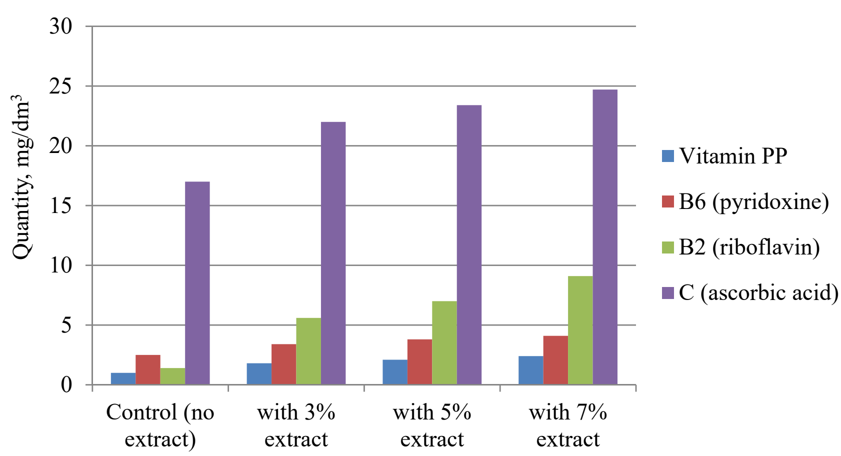

Fig. 4. Amount of vitamins in samples with extract added, n=6, p<0.05

Although the amount of amino acids increased with enhancing extract dose, the variant with 5 % extract is distinguished by its higher organoleptic quality, so that dose was chosen as the rational version.

Among amino acids, the amount of cysteine, which differs in its antioxidant effect, was higher in the sample with 5 % extract added. This factor indicates that, in addition to polyphenols, cysteine also provides antioxidant properties to the drink.

5. 3. Research on the preparation of juice drinks with the application of ceca extracts

With the addition of extracts, 45–50 dkl grape juice separated by its own flow (per 1 ton of grapes) was used in the processing of the Bayanshira grape variety in the "white method" for the production of functional juice drinks. Drinks were prepared in several variants by changing the ratio of grape juice and extracts mixed: variant I – grape juice and extract in a ratio of 95:5, variant II – 90:10, variant III – 85:15, and variant IV – 80:20. As a control, a sample of juice without added extract was taken.

Degustation of a sample of a juiced drink made in the ratio of 80:20 (option IV) showed that the sample has an inharmonious taste, burning acidity, a product-uncharacteristic aroma and high viscosity. Of course, such a sample received a low score during the tasting and was not intended for further research.

Among the samples, variant II, which combined 90 % juice and 10 % extract (90:10 ratio), received the highest rating. According to the tasting results, adding extract to grape juice enhanced the aroma and taste of the drink, gave it a complex tone, resinous hue, and removed the taste of the comb. In general, the consumption characteristics and quality of the finished drink improved in this case.

The mass fraction of sugars decreased from 21.30 g/100 cm^3 to 19.03 g/100 cm^3 as the amount of extract in the drink increased, and the amount of titratable acids decreased from 4.20 g/dm^3 to 4.85 g/dm^3. The pH changed insignificantly, ranging between 3.40 and 3.30.

The acetometric indicator decreases as the amount of sugar and acids changes. Thus, the beverages (variant II) obtained from the coupage of 90 % grape juice and 10 % extract had the rational value of the acetometric indicator of 44.5. This parameter was 51.0 for the I variant and 37.8 for the III variant.

The amount of macro and microelements in obtained functional drinks determines their mineral value (Table 3).

As it can be seen, potassium is the most abundant macronutrient in samples of functional drinks prepared with the addition of extract. Its amount fluctuated between 1610–1622 mg/dm^3 in the samples. At that time, the highest amount was distributed as 1622 mg/dm^3 in variant III, then 1621 mg/dm^3 in variant II, and finally 1610 mg/dm^3 in variant I. Therefore, with the increase in the amount of extract in the drink, the amount of metals in the samples increased.

In terms of quantity, the second place among cations belonged to calcium. Its amount fluctuated between 135.5–148.4 mg/dm^3 in the samples, and the limit of the amount was found in the drink sample taken according to option III.

Table 3

Amount of mineral elements in functional juice drinks prepared by adding extract, n=6, p<0.05

Elements	Mass concentration in bevarege samples, mg/dm^3			
	Control	I	II	III
Potassium	1397	1610.0	1621.0	1622.0
Sodium	34.0	41.3	44.9	49.5
Magnesium	98.7	127.0	124.0	121.0
Calcium	127.3	139.0	135.5	148.4
Total:	1657	1917.3	1925.4	1940.9
Selenium	0.33	0.41	0.41	0.32
Manganese	0.39	0.48	0.48	0.33
Zinc	0.86	0.95	0.88	0.65
Silicon	7.78	9.10	10.36	14.01
Tin	1.37	1.60	1.52	1.52
Iodine	0.8	0.11	0.12	0.12
Total	–	12.65	13.77	16.95

The amount of magnesium in the drink samples was 121–127 mg/dm^3, and the amount of sodium fluctuated between 41.3–49.5 mg/dm^3.

Silica was found in higher amount than trace elements in the drink samples and its amount fluctuated between 9.10–14.01 mg/dm^3. Considering that the total amount of microelements fluctuates between 12.65–16.95 mg/dm^3, it would like to see that its basic amount falls on the share of silicon. Among other trace elements, selenium was 0.33–0.41, iodine 0.11–0.12, manganese 0.33–0.48, zinc 0.65–0.95, tin 1.52–1.60 mg/dm^3.

Acid content of functional drinks prepared by adding extract is also of interest. During the analysis, among the main organic acids – wine, malic, amber, lemon, vinegar and lactic acid were found in the samples (Fig. 5).

Organic acids impart a sour flavor to beverages, participate in oxidation-reduction processes, and have antioxidant properties. In all beverage samples, tartaric acid was more than other acids and even twice the malic acid that followed after it. The amount of citric acid increased with increasing amount of extract in the drink. This rise was nearly threefold in the III variant compared to the I variant. This factor indicates that the extract is richer in the mentioned acid.

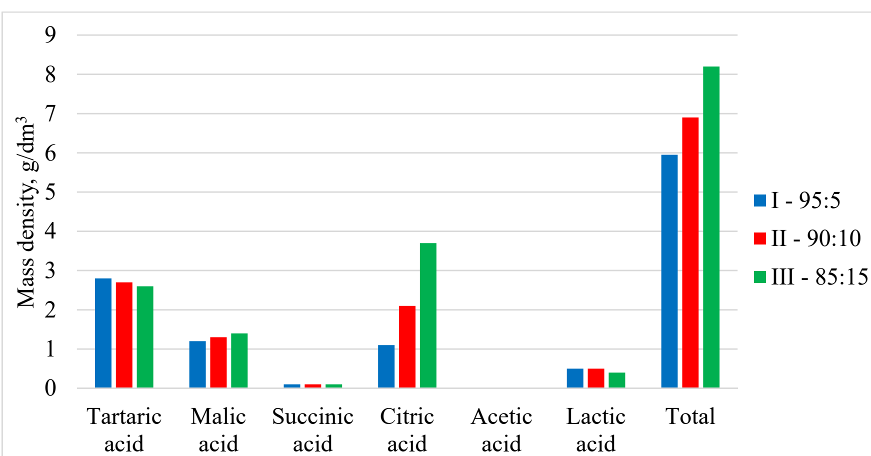

Fig. 5. Amount of organic acids in functional juice drink samples, n=6, p<0.05

The low acetic acid content of drinks is reflected positively in their taste quality. The excess of this amount creates harshness in the taste of the samples and imparts sharp shades to the aroma of the finished product. Lactic acid has a pronounced bactericidal effect and affects the activity of bacteria in human intestines. In this regard, its amount in the samples was not high (0.52–0.57 mg/dm^3) and did not cause complications. Succinic acid was found in all liquor samples, albeit in small amounts.

Thus, the studied samples of functional drinks are enriched with a high amount of biologically active substances and physiologically important components due to the extracts added to their composition. Drink samples are enriched with vitamins, phenolic acids, as well as macro and microelements, all of which are very important for the normal functioning of human life.

The safety indicators of the developed functional drinks were studied in a comparative manner with the permitted norms. As it can be seen, any of the monitored indicators were not higher than the permissible norms. As it can be seen, the safety indicators of the functional drink prepared by adding the extract vary within the norm and fully meet the requirements.

As a result of the application of the developed technological methods, the quality, nutritional value and organoleptic indicators of the finished product are significantly increased, which allows to start the production and sell the drinks.

6. Discussion of the results of improving the technology of functional beverages using the ceca formed during grape processing

The equipment and lines available in the production are not always able to ensure the acquisition of extracted wine material. In order for juice and wine material to be in contact with solid parts for a long time, a large number of equipment and technological vessels, as well as production areas, are required [12]. In this regard, the enrichment of low-extract juice and wine with extracts obtained from the solid parts of the cluster and the production of improved quality wine were studied.

In our research, three types of squeezes were obtained: No. 1 – a mixture of Rkasiteli and Bayanshira grape varieties (pomace obtained by the "white method"); No. 2 – Madrasa and Merlot mixture (sweet ceca obtained after 24 hour maceration of the wine); No. 3 – Madrasa and Merlot mixture (sour blend obtained by the "red method"). Ceca samples were fermented separately under the same conditions (naturally, in the shade). 2 % tartaric acid, 25–30 % alcoholized sour wine, 25–30 % alcohol-juice and 25–30 % alcohol-water mixture were used as extractants. Although 2 % tartaric acid solution provided lower extraction of phenolic compounds, 25–30 % wine-alcohol extractant gave the best results for both options II and III and provided maximum values of phenolic compounds in these options. When 25–30 h % alcoholized juice was used, the high amount of phenolic compounds was noticed in variant II, followed by variants III and I in this regard. The 25–30 h % alcohol-water extractant was noted for giving weaker results than the previous ones (Fig. 1).

A higher amount of polysaccharides in the extracts was observed when 25–30 h% spitted juice was used, and it was found that the main increase was in variants I and II. When other extragens were used, options II and III were superior and the amount of polysaccharides was represented by smaller indicators compared to the previous one (Fig. 2).

Since the mentioned extractants affect the amount of acids, it is possible to continue the research by changing the extractants. At this time, hot water with a temperature of 65–75 °C; three extractants such as 65–75 h% water-alcohol mixture and normal water with a temperature of 18–22 °C were used. As can be seen, tartaric acid was more in options I and II, malic acid in options II and III, and succinic acid in options I and II. Another noteworthy point is that the amount of malic and acetic acids reaches a maximum in variant III (Fig. 3).

Extracts in the amount of 3, 5 and 7 % were added to the juice and wine material obtained by the "white method" from the Bayanshire grape variety. A sample of wine without extract was taken as a control. As the amount of added extract increased, sugar content decreased to 0.1 %, and alcohol content increased by 0.1–0.2 %. A significant increase in the amount of phenolic compounds was observed in the experimental variants compared to the control. If the amount of phenolic compounds was 170.4 mg/dm^3 in the control version, it was 230 mg/dm^3 when 3 % extract was added and 270 mg/dm^3 when 5 % extract was added. Due to the small amount of polyphenols, white dark wines, like juices from white grape varieties, have a low biological value. Eliminating the shortage of this type of drinks, which are in high demand among consumers, is of scientific and practical importance. In accordance with this, an increase in resverutrol and antioxidant capacity was also observed in experimental samples.

During the organoleptic evaluation of the samples, the wine sample prepared with the addition of 5 % extract scored 7.90 points higher than the control sample by 0.35 points. The increase of the extract above 5 % had a negative effect on the organoleptic quality of the drink and, of course, it resulted in its evaluation being 0.05 points lower than the previous sample (Table 1).

An increase in the amount of vitamins was observed in all experimental samples obtained with the addition of the extract. As the amount of extracts increased, a greater increase was observed in the amount of vitamins B_2 and C (7.7–7.8 mg/dm^3), relatively less in the amount of PP and vitamin B_6 (1.4–1.6 mg/dm^3) (Fig. 4).

Despite the increase in the amount of amino acids as the dose of extract increases, the option with 5 % extract is distinguished by higher organoleptic quality, so that dose was chosen as the rational option (Table 2).

In the processing of the Bayanshire grape variety by the "white method", 45–50 dal of grape juice separated by its own flow (per 1 ton of grapes) and mixed amounts of extracts were prepared in several variants: in variant I grape juice and extract 95:5, variant II – 90:10, variant III-85:15 and variant IV-80:20 were mixed. As a control, a sample of juice without added extract was taken.

Among the samples, variant II, i. e. mixing 90 % juice and 10 % extract, i. e. 90:10 ratio, was more highly rated. Based on the results of the tasting, it can be noted that the addition of extract to grape juice enriches the aroma and taste of the drink, gives it a complex tone, resinous hue, and removes the fullness of the comb. In general, it can be said that the consumption characteristics and quality of the finished drink have increased.

The most abundant macroelements in the drink samples are potassium (amount of 1610–1622 mg/dm^3 in the samples), followed by calcium (135.5–148.4 mg/dm^3), magnesium (121–127 mg/dm^3) and sodium (41.3–49.5 mg/dm^3). As the amount of added extracts increased, an increase in the amount of metals was noticed. The total amount of microelements fluctuated between 12.65–16.95 mg/dm^3, and its main amount fell to the share of silicon. Then selenium (0.33–0.41), iodine (0.11–0.12), manganese (0.33–0.48), zinc (0.65–0.95) and tin (1.52–1.60 mg/dm^3) (Table 3).

Among the main organic acids – wine, malic, amber, lemon, vinegar and lactic acid were found in the juice drink samples. Tartaric acid exceeded the other acids in quantity and was even nearly twice as much as malic acid, which followed. As the amount of the added extract increased, the amount of citric acid also increased, and this increase was almost 3 times in the III option compared to the I option. This factor indicates that the extract is richer in citric acid. The low amount of acetic acid has a positive effect on the taste quality of drinks. Lactic acid has a pronounced bactericidal effect, affects the activity of bacteria in human intestines. In this regard, its amount in the samples was not high (0.52–0.57 mg/dm^3) and did not cause complications. A small amount of succinic acid was found in all the drink samples (Fig. 5).

Dark wines made by the "white method" with the current technology are characterized by poor extractability indicators. Dark wines obtained by the "white method" from the Bayanshira grape variety do not have sufficient extractiveness.

The addition of wine-alcohol-cece extract at a concentration of 25–30 %.

The addition of juice-alcohol-ceca extract in the ratio of 90:10 to the grape juice obtained by the "white method" improves its composition and organoleptic properties and gives it functionality.

In the case of juices and wines with high extraction, the application of this method is of a limiting nature.

The disadvantage of the study is that the extract obtained as a result of processing cannot be used directly, which slows down the process. Because when using the extract directly, its organoleptic properties, especially taste qualities, have a side taste. The use of pressing after fermentation gives more favorable results than its direct application and this requires additional time

This method not only gives functionality to the dark wine material obtained by the "white method" in the stream, but also eliminates the loss of process time.

7. Conclusions

1. For better extraction of phenolic compounds, 25–30 h% wine-alcohol and 25–30 h% alcohol-juice extracts; 25–30 h% alcohol-juice, 25–30 h% alcohol-water and 25–30 h% alcohol-wine extracts for better extraction of polysaccharides; From organic acids, 65–70 % water-alcohol mixture for lactic and succinic acid, ordinary water at 18–22 °C temperature for malic and acetic acids, and hot water at 65–75 °C temperature were favorable for moderate extraction of all acids.

2. 25–30 vol% wine-alcohol extract was added to the wine samples in amounts of 3, 5 and 7 %. As the added dose of the extract increases, the amount of phenolic compounds, resveratrol, the extracted extract and the antioxidant capacity, etc. increase was observed. During the organoleptic assessment, the sample with 5 % extract was evaluated higher, the increase of extract above 5 % manifested negatively in the quality, which resulted in its evaluation 0.05 points lower than the previous sample.

3. The rational dose of alcohol-juice extract added to the I type juice obtained from the processing of Bayanshire grape variety at 25–30 h% darkness was determined. It was found that the sample of the drink prepared using 90 % juice and 10 % extract in the coupage is superior to its counterparts with high content indicators, pink color, complex aroma, soft harmonious taste and pleasant aftertaste.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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Data availability

Data will be made available on reasonable request.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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