International Journal of Innovative Research and Scientific Studies, 8(6) 2025, pages: 322-337

IJIRSS International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

Study of the production of functional food products through the application of resource-conserving technologies

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Abstract

The object of the study is rosehips, grapes, juice, rosehip pomace, wine material, auxiliary materials, technological methods, and tools. Although numerous studies have been conducted on the production of various processed products from rosehips, the effect of the application of rosehips and residues formed during their processing on the composition and quality of juice and wine, as well as other functional food products, has not been thoroughly studied. Functional grape juice and wine have been produced from rosehip fruits utilizing both natural fermentation and blending (coupage) techniques, as well as through the incorporation of extracts derived from rosehip pomace. The physicochemical composition and antioxidant properties of the final products have been subsequently assessed. A blending (coupage) report has been compiled, and a scheme of the process has been developed for the production of wine with residual sugar. The optimal method for preparing functional juice and wine with the addition of rosehip pomace extract has been identified. The production of functional yogurt and bread-cake products has involved applying the pomace powder produced during the processing of rosehips. The best options for adding rosehip pomace powder to yogurt and bakery goods have been determined, with 3.0% of the pomace powder's mass used for yogurt and 2.5% for cake, which yielded better results. A probiotic yogurt without additions has been used as a control. It has been found that the addition of rosehip pomace powder enhances the quality of yogurt and results in positive changes in quality with increased shelf life. In the experimental samples, a consistent increase in phenolic compounds has been observed with an increase in the dose of rosehip pomace powder. The optimal formulation has been identified based on compositional parameters and antioxidant properties. The firmness of the cakes increased, and elasticity initially decreased slightly before increasing as the amount of added rosehip pomace powder increased. Although the internal stickiness values varied, they also decreased with increasing amounts of additives. An increase in chewability was observed with the increase in additive amounts. These studies are significant for production in terms of preparing functional juices and wines from wild rosehips, developing a sequential process scheme for preparing wine samples with residual sugar, reporting the blending (coupage), utilizing rosehip extracts as an enrichment agent, and preparing functional yogurt and bread-cake products with the application of rosehip pomace powder. Additionally, the studies focus on analyzing changes in physicochemical composition indicators. The obtained results can be applied in the winemaking, baking, and dairy industries.

Keywords: Antioxidant activity, Dietary fiber, Grape, Pomace extract, Pomace powder, Rosehip.

DOI: 10.53894/ijirss.v8i6.9593
Funding: This study received no specific financial support.
History: Received: 4 July 2025 / **Revised:** 6 August 2025 / **Accepted:** 8 August 2025 / **Published:** 1 September 2025

Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Publisher: Innovative Research Publishing

1. Introduction

As it is known, residues are obtained as by-products during processing operations in the food industry. Some of these food residues, called secondary raw materials, are either discarded without being utilized (causing environmental pollution) or used to produce products of little economic importance (animal feed, fertilizers, etc.) using primitive technologies. The rational utilization of residues generated in the food industry is important not only for environmental protection but also in terms of providing additional economic benefits and increasing the variety of products. It is expected that the number of enterprises engaged in food production and the associated problems of food waste will increase along with the continuous rise in the population. In this regard, the collection of waste and its utilization for the production of new products are important in terms of human health, environmental cleanliness, and the economy of the country. As it is known, food industry waste is rich in a number of nutrients and also contains dietary fibers with important functional properties.

It is necessary to develop and create new high-quality products to ensure proper and healthy nutrition. Such products should be balanced in composition and enriched with various functional properties. Therefore, it is relevant to develop products that incorporate the utilization of fruits and berries with a rich composition, as well as residues from their processing. In this regard, the utilization of wild rosehip fruit and its processing into pomace powder in the production of food products appears promising. It seems important to investigate the effect of its utilization in the production of key food products such as juice, wine, yogurt, and bread from rosehip fruit and its processing residues on the composition and quality of the resulting product.

It should be noted that the preparation of juices and wines from wild rosehips, the utilization of residues formed during rosehip processing in the production of yogurt and bread-cake products, and the effects on their physicochemical composition, quality, and storage have not yet been fully investigated.

According to the above-mentioned factors, we can note that these studies, which are dedicated to preparing juices and wines based on rosehips and processing residues, providing functionality to products utilizing rosehip pomace extracts, and studying the effect of rosehip pomace powder on the composition and quality of yogurt, as well as bread-cake products, are relevant.

2. Literature Review and Problem Statement

Rosa canina L., a species of rosehip, has been studied for oil production. For this purpose, the complex of bioactive compounds has been analyzed in the pomace powder obtained after the seeds are separated. Adding pomace powder to gingerbread improved its overall properties, increased its antioxidant activity, and enhanced its microbiological stability. The optimal amount was determined to be 4% pomace powder [1].

The physicochemical, organoleptic, and colour properties of a beverage enriched with coarsely ground rosehips and small rosehips flour and fermented to lactic acid had been determined. The optimal amount for the drink obtained in the coarsely ground version was 2.76%, and it constituted 0.53% in the flour-ground version [2].

A study had been conducted to determine the morphological characteristics of five species of rosehips. The organoleptic and physicochemical parameters of the biologically active supplement of different varieties of rosehips had been studied, and the previously prepared fruits had been separated from the seeds and extracted with water and ethyl alcohol [3].

Rosehip tea and a mixture containing two rosehips, infusions, and decoctions have been studied in this investigation. Infusions showed higher phenolic acid content and antioxidant activity than decoctions. However, decoction may be preferred as an extraction method due to the accumulation of polysaccharides. The energy value of both extracts was low [4].

The aim of this study is to investigate the biochemical composition of rosehip powder and to develop a recipe for dry mixes that include it for making drinks [5].

An assessment in this study has been made on three areas: unpasteurized juice, pasteurized juice, and unpasteurized pomace. It has been found that unpasteurized pomace powder has higher antioxidant properties than its juice-derived counterparts [6].

In this study, the effect of additive type (maltodextrin, inulin, trehalose, palatinose) and drying technique (spray and freeze-drying) on the physicochemical and antioxidant properties of pasteurized and unpasteurized juice powders has been investigated. The incorporation of additives significantly affected the antioxidant capacity determined by ABTS/TEAC and FRAP assay methods [7].

In this study, 4 recipes were reviewed regarding the replacement of wheat flour in waffles with powder obtained from rosehip residues. These are 0%, 10%, 15%, and 20% options without addition, and are designed to bring the density to 0%, 3.7%, 5.7%, and 7.5%, respectively, based on the total volume of the dough. It has been found that, in order to enrich waffle layers with cellulose, polyphenols, and carotenoids, at least 10% of the wheat flour in the recipe should be replaced with rosehip residue powder [8].

Rosehip seeds are usually discarded as waste. Among other compounds, they also contain oil with high bioactive potential. This oil can be used for the preparation of innovative food, pharmaceutical, and cosmetic products [9].

The demand for functional food is constantly growing. One of the sources is rosehip and products derived from its processing. It has been informed that rosehip has certain potential for utilization in the production of food and non-food products. It is considered important to study this fruit in more detail and determine its application possibilities. The nutritional and phytochemical composition of rosehips, as well as their biological activity, have been comprehensively investigated. In addition, the numerous possibilities of application of rosehip fruits in the food, chemical, and poultry industries have been studied. It is noted that extracts obtained from rosehips can also be successfully used in these industrial fields [10].

This review provides lipid characteristics of rosehip seed, including oil, depending on the extraction method. Rosehip oil has been proven to be rich in polyunsaturated fatty acids, stearic acid, and tocopherols. They are known to provide specific biological activity. The oil content in rosehip seed ranges from 5-18%, consisting of unsaturated acids such as linoleic, linolenic, and oleic acids. The amount of styrene was 5 g/kg [11].

The production of antioxidant beverages from whey by direct extraction utilizing dried rosehip fruits is being studied. In this case, better indicators in terms of antioxidant activity and vitamin C content have been observed in the beverage obtained with the following technological parameters: hydromodulus 1:20, temperature 0-4^{0}C, and extraction duration 3 hours. The direct extraction method of dried fruits into whey can be successfully used in the development of new functional beverages and in the recycling of by-products in the cheese industry [12].

Fermented whey beverages from goat and cow milk have been obtained by enriching them with sea buckthorn or rosehip juice. It has been found that the addition of organic fruit juices significantly improved the properties of fermented whey beverages [13].

Vinegar obtained from black rosehip (Rosa pimpinellifolia L.) has been reported to be rich in aromatic compounds and functional properties. Black rose has been reported to be a suitable raw material for the production of vinegar. Such vinegar contained 28 volatile compounds, in particular 2-phenylethanol, mint oil, octane tartrate, ethyl acetate, phenylethyl acetate, 3-methyl-1-butanol, as well as hexyl salicylate, 4-terpineol, and dihydromethyl jasmonate [14].

It has been found that rosehips contain vitamin C 60 times more than oranges. They prevent cancer, lower cholesterol levels, are good for the heart, and treat colds. They also aid digestion, regulate blood pressure, and improve skin and kidney health. The bioactive compounds are increased when rosehips are processed using closed-loop technology [15].

Rosehip decoction and tea have been studied. In this case, rosehips were dried at 40, 50, and 60^{0}C using the convective drying method, and their content of phenolic compounds, flavanols, anthocyanins, and antioxidant properties were investigated. All decoction samples exhibited high inhibitory potential. In particular, the decoction prepared from the rosehip mixture dried at 60^{0}C showed higher activity [16].

The production of juice and wine of various colours and types from autochthonous red and white grape varieties and the factors affecting it have been investigated [17] and the preparation of extracts, nectars, etc., from rosehips and other fruits and berries, as well as their processing residues, and their reuse [18] also their chemical composition [19] have been investigated.

3. The Aim and Objectives of the Study

The aim of the study is to investigate the effect of rosehip fruit and its processing residues on the composition and quality of various food products.

To achieve this goal, the following objectives are pursued:

- Study of the production of functional juices and wines utilising rosehip and bilberry extracts
- Study of the effect of rosehip pomace powder on the quality and shelf life of yogurt
- Study of the effect of rosehip pomace powder on the physicochemical composition and storage of bread-cake products.

4. Materials and Methods of Research

The object of research is rosehip fruit, juice, pomace, seeds, wine material, auxiliary materials, technological methods, and tools.

The main idea of the research is to study the physicochemical composition of functional juices and wines prepared by utilizing rosehip fruits grown in different regions and their processing residues, as well as the effect of pomace powder added in yogurt and bread production on the composition and quality. The application of modern analysis methods greatly simplifies the issues in the study.

The research material consisted of samples (raw material, juice, and crush) obtained by various methods from the fruits of the rosehip plant grown in the Dashkasan, Goygol, and Gadabay districts of the Ganja region. The samples had been frozen and stored at -20^{0}C until analysis. Before analysis, the samples should be removed from the freezer and brought to room temperature. At the same time, aboriginal and introduced grape varieties, juice, and wine samples cultivated in the region have been utilized.

After washing the rosehip fruit, it is cleaned of stems and damaged fruit. The fruits are mixed with water in a ratio of 1:3 and subjected to heat treatment at a temperature of 70-80^{0}C for 4 minutes. The previously heat-treated fruits have been grated and crushed. Then, water is added to the crushed fruit in a ratio of 1:3 to obtain fruit juice. It is pasteurized at 100^{0}C for 15 minutes. The pasteurized fruit juice is filled into jars while hot and cooled to 30^{0}C.

For the preparation of juices and other non-alcoholic functional drinks, an enriching pomace extract extracted with hot water has been used, and for wines, a wine-alcohol pomace extract has been used. In both cases, after the separation of the rosehip juice, the remaining pomace is spread out in a thin layer and fermented. Then, it is divided into equal amounts and extracted with the two different extractants mentioned above. In the first case, distilled hot water has been used, and in the second, 25-30% alcohol sour wine material has been used.

To prepare the juice, an equal amount of aboriginal and introduced red grape varieties (Madrasa, Khindogni, and Merlot) has been blended, and rosehip pomace extract has been used as an enricher. Water-extracted rosehip pomace extract was used to add to the juice. In this case, variant I-control (without adding rosehip pomace extract), variant II-1%, III-4%, IV-7%, and V-10% rosehip extract had been added. The amount of grape juice in all variants was the same for all three varieties.

During the preparation of functional wine samples utilizing the application of rosehip wine-alcohol pomace extracts, the extract was blended with juice from a grape variety in different proportions concerning varietal purity. The studies were conducted on the following options.

I variant Control – Madrasa 100%

II variant Madrasa 95% + rosehip pomace extract 5%

III variant Madrasa 90% + rosehip pomace extract 10%

IV variant Madrasa 85% + rosehip pomace extract 15%

V variant Madrasa 80% + rosehip pomace extract 20%

Yogurt samples had been prepared utilizing rosehip pomace powder in five variants, including the control. The control (variant I) sample had not been supplemented, and the amount of rosehip pomace powder added in variant II was 1%, in variant III 2%, in variant IV 3%, and in variant V 4%. The samples had been analyzed after 1 day, 1 week, 2 weeks, and 3 weeks.

Pasteurized milk is heated to 90^{0}C , then cooled to 45^{0}C, and probiotic culture and different amounts of yeast powder have been added to it. The amount of starter culture added to the yogurt samples and the fermentation temperature have been according to the recipe of the culture used. The milk heated to 90^{0}C is cooled to 45^{0}C, and 0.1% probiotic yogurt culture (Streptococcus, Thermophilus, Lactobacillus, Acidophilus, Lactobacillus bulgaricus, and Bifidobacterium animalis, ssp. lactis) has been added to the pasteurized milk. After the yogurt culture is mixed into the milk until a homogeneous mass is obtained, the samples are fermented at 45^{0}C. During the fermentation process, the pH indicator has been continuously measured, and the fermentation has been completed when the pH of the probiotic yogurt samples reaches 4.6. The samples have been stored in a refrigerator at 4^{0}C. During storage, the microbiological and physicochemical composition of the samples has been analyzed.

Flour, milk, eggs, vegetable oil, sugar, baking powder, and margarine have been used to grease baking pans for the production of bakery products.

For moisture determination, the drying containers have been dried in a drying cabinet at 105^{0}C for 30 minutes and then allowed to cool to room temperature. The samples have been mixed until a homogeneous mass has been obtained, 3-5 g have been weighed and spread into drying containers. They have been dried in a laboratory drying cabinet at 105^{0}C for about 2 hours until a constant weight has been reached. After the dried samples cool, their moisture content and dry matter content have been calculated. The amount of moisture,

Moisture, % = $\frac{Ç_2-Ç_1}{m}\times 100$,

here, $Ç_1$ - the weight of the container before drying;

$Ç_2$ - the weight of the container after drying, m - the amount of sample.

A small amount of nitric acid is poured into the crucibles and kept overnight when determining the ash content. Then, it is washed with distilled water and dried in a drying cabinet at 105^{0}C until a constant weight is obtained. Subsequently, 2-3 g of the dried sample is taken and placed inside the crucible for moisture determination. The crucibles are then placed in a muffle furnace, and the temperature is gradually increased to 500±1^{0}C. The combustion process continues until the samples reach a gray-white color. The ash content is determined using the following formula:

Ash, %= $\frac{M_2-M}{M_1-M}\cdot 100$,

here: M – weight of the container, g;

M_1 – weight of the container with sample, g;

M_2 – weight of the container with ash, g.

Colour analysis of yogurt samples has been performed using a HunterLab (Konica Minolta CR-5, Japan) colorimeter. After calibrating the device, the samples were placed in a container suitable for solid samples, and the three parallel indicators L (lightness), b (blue-yellow), and a (green-red) were measured.

Texture analysis profiles of yogurt samples in 100 ml plastic sample containers had been measured during storage by utilizing a Stable Micro System TA/XT Texture Analyzer and a 35 ml disc-shaped probe. The probe advances at a speed of 1 mm/sec over the sample surface and enters 75% of the sample, then withdraws at a speed of 10 mm/sec. The ratios of firmness, internal stickiness, and chewability characteristics to internal stickiness of the yogurt samples have been determined.

When determining the water retention capacity of samples, 10 g (Y) of homogenized yogurt samples have been weighed from the centrifuge and centrifuged at 5000 rpm for 20 min at +4^{0}C. The mass of the remaining part (Q) after removing the solid part in the centrifuge tube has been determined. The water retention capacity (in % WHC) has been calculated by utilizing the following formula.

WHC %-lə = $\frac{Q}{Y} \times 100$

The amount of whey filtered through a 25 g yogurt sample through a No.1 Whatman filter paper for 120 minutes at +4^{0}C has been weighed and the amount in % has been calculated.

During the organoleptic assessment of yogurt samples, tasters rate the samples on a scale of 1-5. In this case, 1 point is considered very bad, 2 points are bad, 3 points are average, 4 points are good, and 5 points are very good.

The analysis of soluble, insoluble, and total dietary fibers in bakery products has been carried out in accordance with AACC 32-07 and AOAC 991.43 methods, utilizing the Megasum total dietary fiber analyzer containing protease, alpha-amylase, and amyloglucosidase enzymes.

At the beginning of the analysis, gelatinization was performed with alpha amylase at 95-100^{0}C to hydrolyze the digestible starch in the sample. Subsequently, enzymatic treatment was carried out with protease and amyloglucosidase enzymes at 60^{0}C to remove digestible proteins. The obtained mixture was filtered through a vacuum filter. The residue remaining on the filter was washed with distilled water. After removing the filter from the residue section, this section was washed sequentially with ethanol and acetone. This additional part, where the washing was completed, reflects insoluble salts, insoluble dietary fiber, and indigestible proteins. To precipitate the soluble fraction of dietary fiber, ethyl alcohol was added to the collected filtrate and kept at room temperature for 1 hour. The resulting turbid part was then filtered through the filter and washed sequentially with ethyl alcohol and acetone. This turbid mass also contains proteins and minerals that cannot be digested in the soluble fraction of dietary fiber. The crucibles containing soluble and insoluble dietary fibers were weighed after drying overnight at 103±2^{0}C. Subsequently, protein and ash determinations were performed to detect remaining proteins and salts. After calculating the results of protein and ash analyses, the amounts of soluble and insoluble dietary fiber were calculated by substituting the results into the formula.

The physicochemical and organoleptic characteristics of raw materials, semi-finished products, and finished products have been determined by common analysis methods available in enochemistry [20, 21]. However, modern analysis methods, computer technology, and statistical processing of data have been used in the study. Statistical analyses were performed using the SPSS 18 package [22, 23].

Hunterlab (Model D-9000 Color Difference Meter) analyzer was used to measure the colour of wine samples. In Hunter, a-value measures redness and greenness, and b-value measures yellowness and blueness. The L-value measures the degree of lightness or brightness. The price varies between 100 – full white, 0 – black.

The amount of total phenolic compounds has been determined using the Folin-Ciocalteu (FC) method. Calibration curves were constructed using hydrochloric acid solutions with concentrations ranging from 5 to 10 mg/l.

In the analysis of samples, 1 ml of sample extract has been mixed with 5 ml of 1:10 FC (Folin-Ciocalteu) solution and 4 ml of 75 g/l Na_2CO_3. After the mixture has been kept in the dark at room temperature for 2 min., the absorbance values at 760 nm have been read in a spectrophotometer. Drying has been applied to samples with absorbance values outside the calibration curve. For the results, the amount of total phenolic compounds in each gram of dry sample has been calculated by converting to mg of gallic acid (GAE).

As a result of the studies, the production of functional juices and wines utilizing different techniques based on wild rosehips and processing residues in various regions will be studied, and the effect of rosehip powder on the physicochemical composition, storage, and quality of yogurt and bread-cake products will be determined.

5. The Results of the İnvestigation on the Study of the Effect of the Application of Resource-Conserving Technologies on the Composition of Functional Food Product Samples

5.1. Investigation on the Production of Functional Juices and Wines by Utilising Rosehip and Pomace Extracts

In the production of juice from rosehips, which are rich in extractive substances, especially polysaccharides and polyphenols, further fermentation is impossible without applying special technological techniques. In this regard, operations such as treatment with enzyme preparations, dilution with water, and addition of sugar have been performed to break down polymers. The physicochemical composition of juice samples prepared from rosehips purchased from different regions is given (Figure 1).

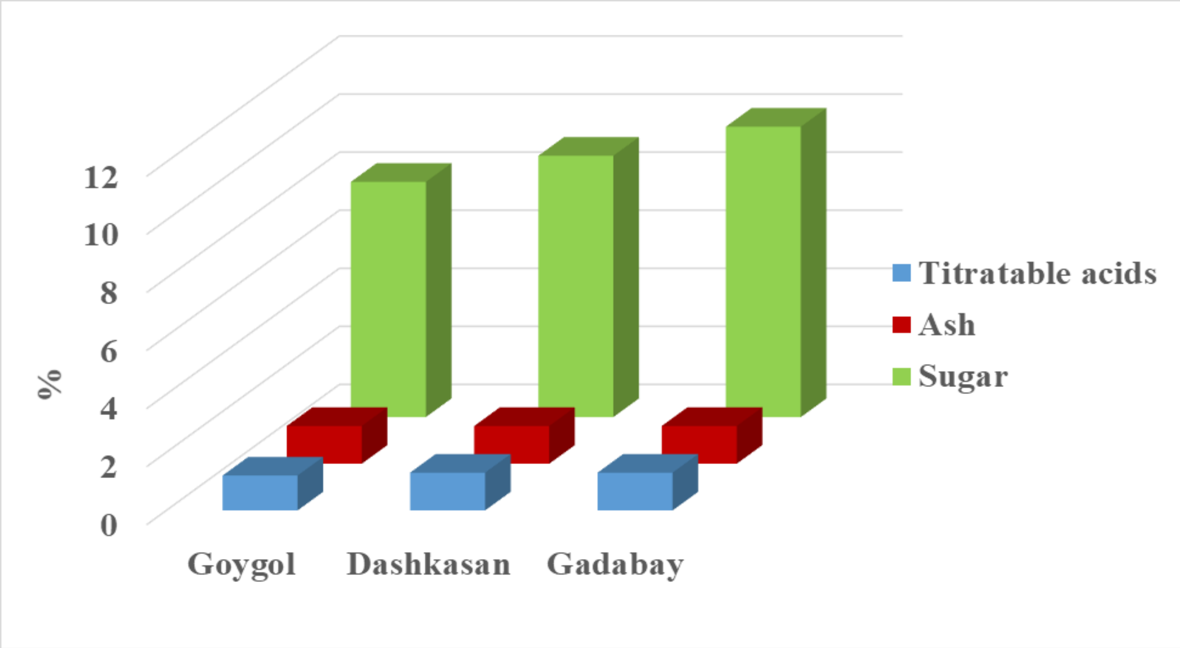


Figure 1.
Some compositional parameters of rosehip juice samples, n=6, p<0.05.

As can be seen, the sugar content in the juice samples ranged from 9.01-10.22%, the titratable acids converted to malic acid from 1.01-1.12%, and the ash content from 1.15-1.19%. No significant differences had been observed between the samples and it had been found to be suitable for further processing.

It has been found that to make 100 dal of rosehip wine, 166 kg of rosehip fruit, 1200 dm^3 of drinking water, 234 kg of sugar must be mixed, to which 0.47 kg of yeast, 0.1 kg of sulfite anhydride, and 0.3 kg of ammonium phosphite must be added as yeast feed.

Fermentation had been carried out at a temperature of 20-24^{0}C, and fermentation had been regularly monitored. The compositional parameters of the taken wine samples had been analyzed (Figures 2, 3).

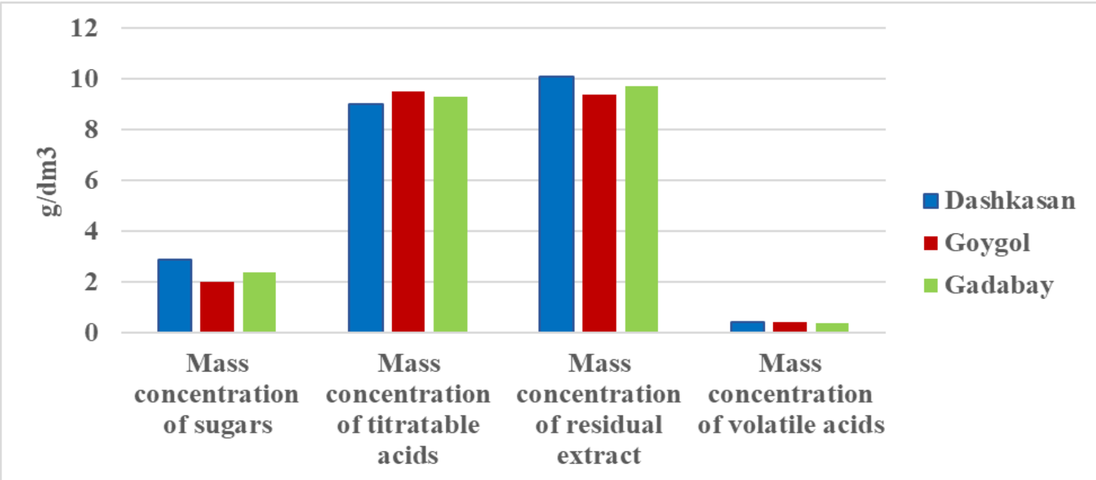


Figure 2.
Some physicochemical composition indicators of sour wine samples obtained from rosehip fruit, n=6, p<0.05.

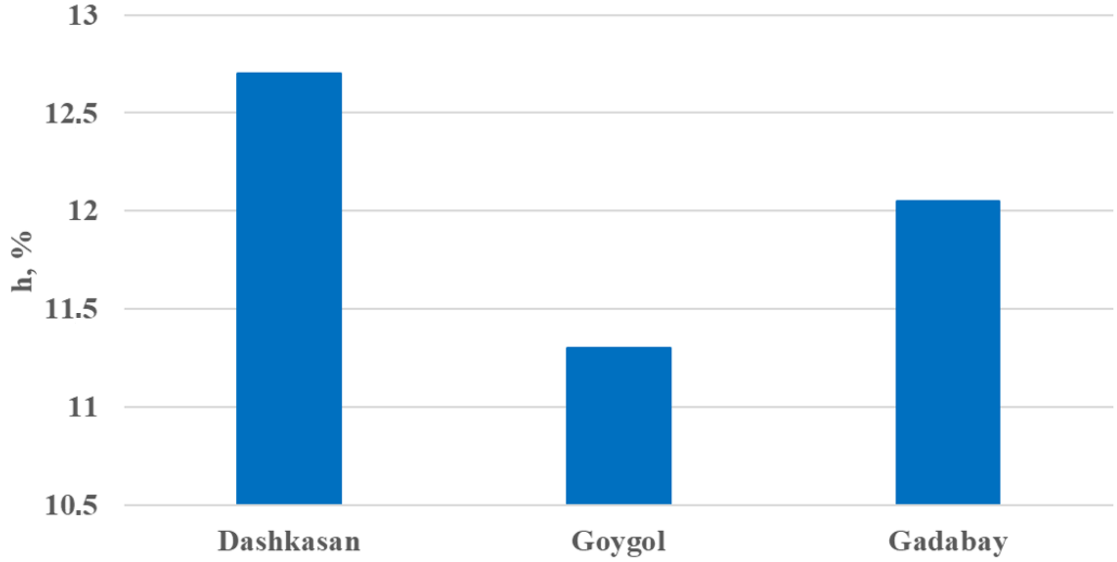
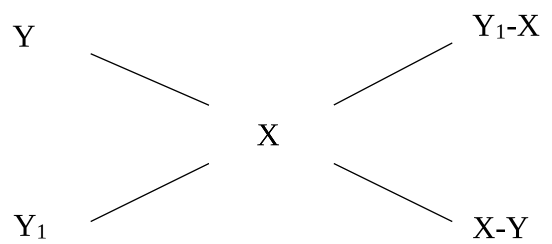


Figure 3.
Alcohol content by volume in rosehip sour wine samples, n=6, $p<0.05$.

As it can be seen, sour wine samples had been obtained by fermenting to the end (residual sugar 0.25-0.30%). At this time, the highest alcohol content (12.7%) had been observed in the Dashkasan sample, and the lowest alcohol content (11.3%) had been observed in the Goygol sample. At this time, the Gadabay sample occupied an intermediate position with an alcohol content of 11.3 h%.

Studies have been conducted to prepare wines with residual sugar based on the prepared sour wine and rosehip juice. Meanwhile, the average sugar content of the rosehip juice obtained by blending was 10%, while the sour wine material had no sugar content. A blending asterisk had been established according to the sugar content of the wine, with residual sugar to be obtained.



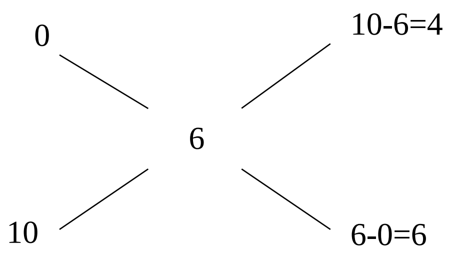
Here, X – the amount of required sugar;

Y – sugariness before coupage (blending);

Y_1 – content ingredient used to increase sugar;

X-Y və Y_1-X – the ratio of the components of the blend (coupage) to provide the required composition.

If we write the values, the form will look like this:



Y_1=1000·6/4=1500 dal=1500 dal

As can be seen, to prepare a sweet wine by increasing the sugar content of 1 dal of sour table wine to 6%, 1.5 dal of rosehip juice with a sugar content of 10% should be included in the blend.

The compositional indicators of semi-sweet wine samples obtained from rosehip fruit had been analyzed (Table 1).

Table 1.
Physicochemical indicators of rosehip semi-sweet wine samples, n=6, p<0.05.

Wine samples	Physicochemical indicators						
	Mass density of sugars, g/dm^3	**Mass concentration of titratable acids, g/dm^3**	**Mass concentration of residual extract, g/dm^3**	**Alcohol content, h% %**	**Mass concentration of volatile acids, g/dm^3**	**Mass density of sulfite anhydride, mg/dm^3**	**pH**
Dashkasan	60.0	7.1	16.5	11.5	0.48	60.0	3.4
Goygol	65.1	6.0	16.2	11.2	0.44	84.3	3.3
Gadabay	66.0	6.2	17.1	10.9	0.36	45.8	3.4

In the samples of semi-sweet wine prepared by coupage, the mass concentration of sugars varied between 60.0-66.0 g/dm^3, the residual extract ranged from 16.2-17.1 g/dm^3, alcohol content was between 10.9-11.5 h%, and the amount of volatile acids ranged from 0.36-0.48 g/dm^3. In this case, the highest alcohol content was observed in the Dashkasan sample, while the lowest was in the Gadabay sample. Conversely, the residual extract was higher in the Gadabay sample and lower in the Goygol sample. The samples fully met the requirements for fruit wines in terms of their compositional indicators and organoleptic properties.

According to the conducted studies, a process scheme for the preparation of sweet wine from rosehip sour wine material had been prepared (Figure 4).

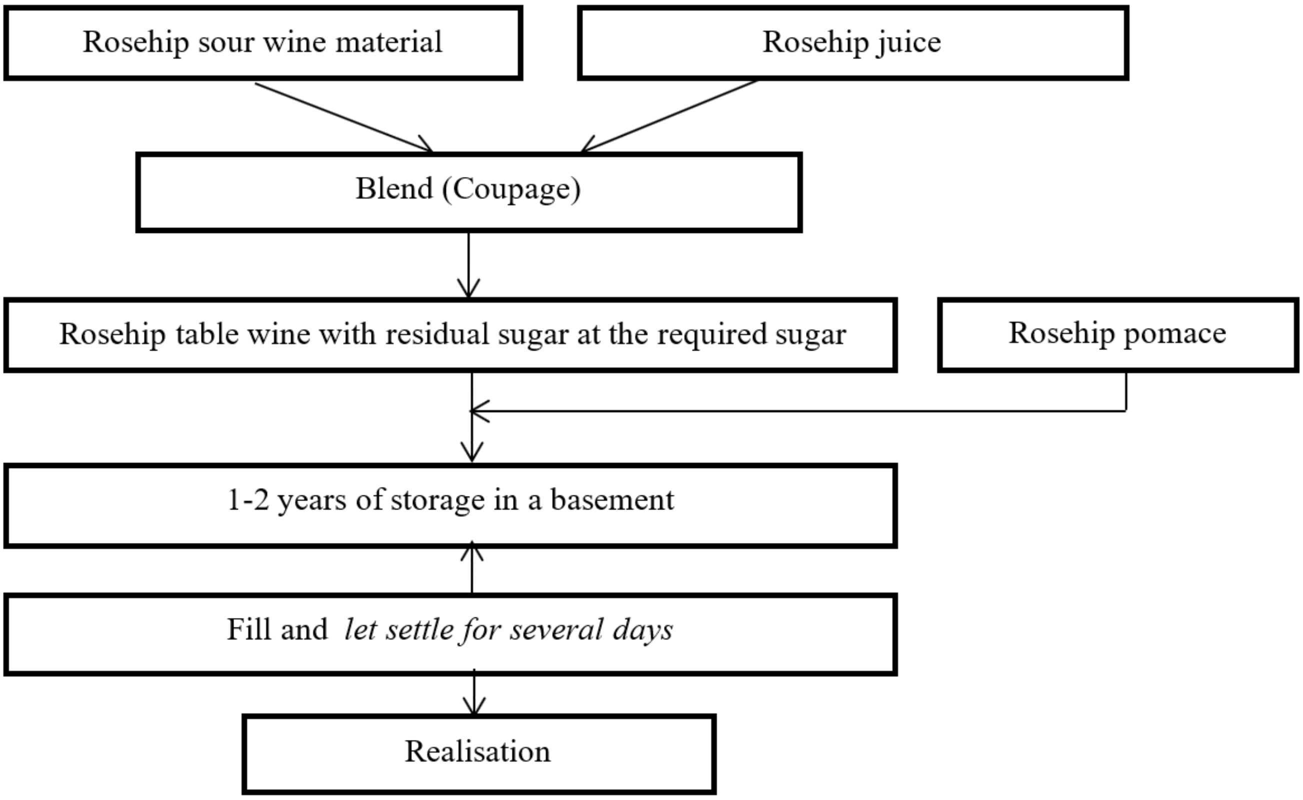


Figure 4.
Process scheme for making wines with residual sugar from rosehip by blending (Coupage).

Filling and letting it rest for a few days. As can be seen, the rosehip sour wine material had been blended with rosehip juice and as a result, a rosehip sour table wine material with a sugar content of 6% had been obtained. Then, if necessary, 1-3% rosehip pomace extract had been added to it. The obtained wine sample had been stored in the cellar and then bottled, and after bottling, it had been left to settle for 2-3 days before being sold.

In studies conducted to prepare functional juice and wine using rosehip pomace extract, a blend of components from different grape juice varieties was first carried out, and more optimal options were identified (Table 2).

Table 2.
Quantitative ratio and organoleptic assessment of components in the production of functional grape juice with the application of rosehip pomace extract, n=6, p<0.05.

Experiment samples	Amount of blend components and additives, %				Tasting score, point
	Khindogni	Merlot	Madrasa	Rosehip pomace extract	
1	33.33	33.33	33.33	0	11.6
2	33.0	33.0	33.0	1.0	12.5
3	32.0	32.0	32.0	4.0	15.9
4	31.0	31.0	31.0	7.0	17.6
5	30.0	30.0	30.0	10.0	16.8

As can be seen, the introduced Merlot grape variety had been used in the blend along with the aboriginal Khindogni and Madrasa grape varieties. In the control variant, rosehip pomace extract had not been used. In other variants, the amount of utilized rosehip pomace extracts had increased. During the organoleptic evaluation of the prepared juice samples, it was found that the samples with added rosehip pomace extracts had been rated higher than the control during tasting. If the control sample received 11.6 points in the scoring with a 20-point system, the other samples had been rated 0.9-6.0 points higher than it. As it can be seen, the highest tasting score was achieved when the added amount of rosehip pomace extract was 7% (IV variant). A further increase in the amount of added rosehip pomace extract led to a weakening of the organoleptic quality. The fourth variant, that is, the option of utilizing 7% rosehip pomace extract, was determined as the best variant. The physicochemical composition of the prepared juice samples has been analyzed (Table 3).

Table 3.
Physicochemical composition indicators of the prepared functional juice, n=6, p<0.05.

Physicochemical composition indicators	Experiment variants				
	Control (1)	2(1%)	3(4%)	4(7%)	5(10%)
Amount of dry matter, %	24.7	25.3	25.8	26.1	26.5
Sugar, %	23.0	22.9	22.0	21.5	20.4
Phenolic compounds, mg/dm^3	680	685	730	790	805
Antioxidant capacity, µm Trolox/g	25.1	27.3	51.6	85.9	91.5

As can be seen, the amount of dry matter in the juice samples ranged between 24.7-26.5%, and the sugar content between 20.4-23.0%. The significant difference between the samples was in the amount of phenolic compounds and antioxidant capacity. It had been found that, compared to the amount of phenolic compounds in the control sample, the amount of phenolic compounds in the experimental samples increased as the dose of additives increased. If in the juice sample with added 1% (variant 2) there was an increase of 5 mg/dm^3, in the last variant with 10% added, this amount was 125 mg/dm^3. A corresponding situation had been observed in the antioxidant capacity of the samples. Thus, in comparison with the control sample, the antioxidant capacity of the experimental samples increased significantly with the amount of additives. Compared with the control, the highest antioxidant capacity was in variant 5 with added 10%, and this indicator was 91.5 µm Trolox/g. Although the latter option prevailed according to these indicators, the fourth option, with the addition 7% pomace extract, was considered optimal in terms of organoleptic evaluation and other compositional indicators.

The results obtained during the research conducted towards the preparation of functional wine samples utilising the application of rosehip pomace extract are presented (Table 4).

Table 4.
Production of functional wines by utilising rosehip pomace extract, n=6, p<0.05.

Experiment samples	**Alcohol. h %**	**Sugar. %**	**Titratable acidity. g/dm^3**	**Volatile acidity.g/dm^3**	**The amount of phenolic compounds. mg/dm^3**	**pH**	**Glycerin**	**Tasting price. point**
I variant Control- Madrasa 100%	12.3	-	7.6	0.71	766	3.25	7.80	74.1
II variant - Madrasa 95%+ rosehip pomace extract 5%	12.3	-	7.6	0.73	775	3.30	7.82	74.6
III variant- Madrasa 90% + rosehip pomace extract 10%	12.4	-	7.7	0.68	804	3.20	7.86	75.8
IV variant- Madrasa 85%+ rosehip pomace extract 15%	12.6	-	7.8	0.74	865	3.10	8.01	78.1
V variant- Madrasa 80%+ rosehip pomace extract 20%	12.5	-	8.0	0.86	890	3.00	7.90	77.4

It is evident from the table that the alcohol content in the prepared wine samples did not vary significantly, ranging between 12.3% and 12.6%. The concentration of phenolic compounds in the wine samples increased with the rising dose of added rosehip pomace extract. Specifically, the phenolic content in the control sample was 766 mg/dm^3. When 5% rosehip pomace extract was used, the phenolic content increased to 775 mg/dm^3. At 10%, it reached 804 mg/dm^3. With 15%, the phenolic compounds further increased to 865 mg/dm^3, and at 20%, they reached 890 mg/dm^3. This trend indicates that the phenolic compound concentration correlates positively with the amount of rosehip pomace extract added. Regarding organoleptic quality, the sample with 15% rosehip pomace extract was rated the highest, scoring 4 points above the control and 0.7 points higher than the sample with 20% extract. This suggests that while phenolic content increases with higher extract doses, the optimal organoleptic quality was observed at 15% extract addition, balancing phenolic enhancement and sensory attributes.

5.2. Study of the Effect of Rosehip Pomace Powder on the Physicochemical Composition, Storage, and Quality of Yogurt

The compositional parameters of yogurt samples prepared by utilizing rosehip pomace powder had been studied. The experiment was carried out in five variants, including the control. No additives had been applied to the control sample. In variant II, the amount of rosehip pomace powder was 1%; in variant III, 2%; in variant IV, 3%; and in variant V, 4%. Yogurt samples had been prepared with the incorporation of additives (Table 5).

Table 5.
Study of yogurt samples prepared by utilising additives during the storage period, n=6, p<0.05.

Variants	Composition indicators	Storage period, days			
		1	5	10	15
Control I	Dry matter, %	11.90	11.91	11.92	11.94
II (1%)		11.34	11.51	11.92	12.09
III (2%)		12.31	12.33	12.44	12.61
IV (3%)		12.86	13.02	13.25	13.51
V (4%)		13.25	13.55	13.72	13.80
Control I	pH	4.21	4.23	4.24	4.29
II (1%)		4.31	4.32	4.30	4.34
III (2%)		4.44	4.43	4.43	4.35
IV (3%)		4.14	4.02	3.96	3.90
V (4%)		4.10	4.08	4.03	3.94
Control I	Titratable acidity, %	0.65	0.70	0.71	0.71
II (1%)		0.66	0.67	0.71	0.71
III (2%)		0.69	0.75	0.75	0.78
IV (3%)		0.71	0.72	0.79	0.81
V (4%)		0.74	0.75	0.84	0.84
Control I	Water retention capacity, %	53.96	54.61	57.76	47.83
II (1%)		52.41	50.11	52.14	42.36
III (2%)		52.11	53.04	53.32	46.25
IV (3%)		48.31	54.32	53.41	50.87
V (4%)		47.64	53.61	54.73	49.31
Control I	Whey separation, %	38.97	37.61	37.52	37.44
II (1%)		37.65	36.46	36.54	35.94
III (2%)		37.22	36.98	35.74	35.04
IV (3%)		37.06	36.96	36.07	35.64
V (4%)		35.72	35.46	34.65	34.03

As can be seen, the amount of dry matter, one of the most important quality indicators of yogurt, was characteristic of different values in the variants, and as the storage period increased, an increase in the amount of dry matter was observed in all cases. At the same time, an increase in the amount of additives was also observed with an increase in the amount of dry matter. Thus, if in variant II (1%) the amount of dry matter was 11.34% on the first day of storage, then in variant V (with the application of 4% additives) this amount was 13.25%. In variant II, the amount of dry matter on the first day of storage was 11.34%, and on the 15th day of storage, it was 12.09%. A similar situation was observed in other variants.

The pH indicator on the variants was similar to the control and previous variants, with a slight increase in variant III, while a decrease was observed during storage in variants IV and V. During storage, there was a slight increase in the amount of titratable acids, a decrease in water retention capacity, and a decrease in whey separation.

Protein, ash content and antioxidant properties had been studied in yogurt samples prepared with the addition of rosehip pomace powder (Table 6).

Table 6.
Effect of the dose of pomace powder on the physicochemical composition of yogurt samples, n=6, p<0.05.

Variants	Composition indicators		
	Protein, %	Ash, %	DPPH (EC_{50} value)
Control I	3.07	3.15	114.46
II	3.21	3.74	127.21
III	3.18	3.96	133.12
IV	3.19	4.03	141.15
V	3.20	4.15	96.67

As it can be seen from the Table, in the Control-I (without the incorporation of pomace powder) variant, the amount of proteins was 3.07%, but with increasing the dose of the applied additive, an increase in this amount was observed to some extent. In this case, in the V variant, the amount of proteins was 3.20%. At the same time, an increase was also noticeable in other indicators.

Interesting changes had also been observed in the amount of phenolic compounds with increasing doses of pomace powder (Figure 5).

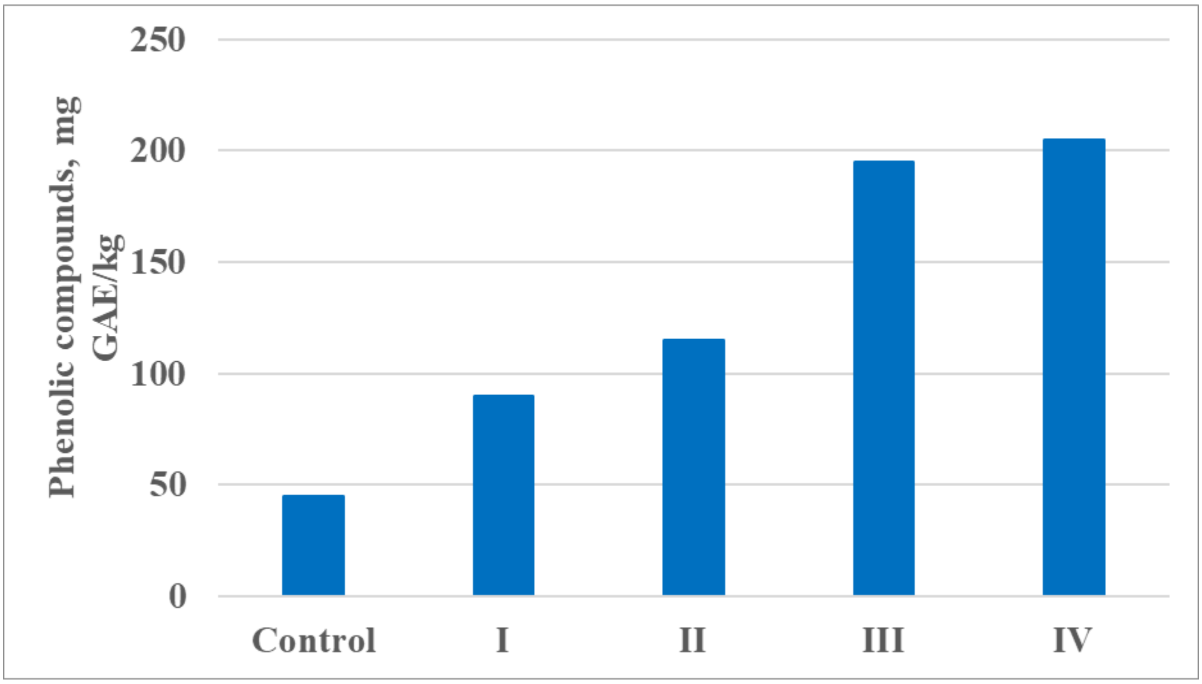


Figure 5.
Amount of phenolic compounds in yogurt samples, n=6, p<0.05.

As can be seen from the figure, the amount of phenolic compounds in the control sample was 44.10 mg GAE/kg. An increase in the amount of phenolic compounds has been observed when additives derived from residues have been applied. In the variant in which 1% of the powder obtained from rosehips was added (experiment II), the amount of phenolic compounds was 87.30 mg GAE/kg, and as the amount of the additive increased, a regular increase in the phenolic compounds was observed. The greatest increase was observed when 4% of the additive was applied, reaching 201.46 mg GAE/kg. However, according to other indicators of composition and organoleptic properties, variant IV was considered optimal.

The colour values of the prepared yogurt samples have been studied and the following results have been obtained: (Table 7).

Table 7.
Variation of colour values in combined yogurt samples, n=6, p<0.05.

Variants	Colour values		
	L	A	B
Control I	87.96	-0.94	1.36
II	86.33	-0.04	1.95
III	86.11	0.21	2.01
IV	85.96	0.27	2.21
V	84.86	0.34	2.30

Meanwhile, the L value varied between 84.86 and 87.96, and the b value ranged from 1.36 to 2.30 across the samples. The lowest L value was observed in variant V, while the highest was in variant Control-I. Conversely, the b value was lowest in variant Control-I and highest in variant V.

Organoleptic evaluation of prepared yogurt samples had been carried out (Table 8).

Table 8.
Organoleptic analysis of yogurt samples prepared with the incorporation of powders obtained from residues, n=6, p<0.05.

Variants	Appearance	Colour	Consistency in a spoon	Consistency in the mouth	Smell	Taste
Control I	3.65	3.51	3.07	3.36	3.45	2.96
II	3.50	3.93	3.36	3.50	3.81	3.65
III	3.96	3.50	3.36	3.50	3.96	3.07
IV	4.15	4.02	4.22	4.22	4.05	4.11
V	3.60	3.48	3.06	3.34	3.43	3.0

As can be seen, option IV had been rated higher during organoleptic analysis, which was somewhat consistent with the results of the physicochemical analysis.

5.3. The Effect Of Rosehip Pomace Powder on the Physicochemical Composition And Storage Of Bread-Cake Products

Studies have been conducted on the preparation of bread-cake products using rosehip pomace powder. First, the composition of the used raw materials and additives was analyzed. The results are given on a dry matter basis (Table 9).

Table 9.
Chemical composition indicators of used raw materials and additives, g/100 g, q/100 q, n=6, p<0.05.

Indicators	Raw materials and additional materials	
	Raw material (flour)	Rosehip pomace powder
Proteins	9.96	5.93
Fats	1.21	9.44
Soluble dietary fiber, %	1.32	3.41
Insoluble dietary fiber, %	1.43	30.21
Ash	0.45	3.01
Total phenolic compounds, mg GAE/100g	96.3	9231.5
Antioxidant activity, µmol TE/100g	1.9	4819.3
Colour values:		
L	95.21	45.32
a	0.51	8.96
b	9.06	18.98

It has been found that, except for the amount of proteins, other compositional indicators were higher in the rosehip pomace powder. In particular, a significant increase was observed in the amount of total phenolic compounds, fats, and insoluble dietary fiber. Thus, the powder differed from flour in terms of fats, phenolic compounds, insoluble dietary fiber, and antioxidant activity. The physicochemical compositional indicators of the samples prepared with the application of additives are given below (Table 10).

Table 10.
Physicochemical composition indicators of samples prepared with the application of additives, n=6, p<0.05.

Indicators	Amount in the finished product of the variants				
	Control I	II (1.5%)	III (2.0%)	IV (2.5%)	V (3.0%)
Proteins	6.15	6.08	5.94	5.88	5.87
Fats	24.61	24.22	24.36	24.87	24.96
Ash	1.82	1.91	1.99	2.04	2.11
pH	7.25	7.01	6.96	6.87	6.64
Soluble dietary fiber, %	1.12	1.35	1.51	1.61	1.69
Insoluble dietary fiber, %	1.38	2.96	5.30	6.25	7.30
Total phenolic compounds, mg GAE/100g	76.93	89.61	116.22	161.36	192.47
Antioxidant activity, µmol TE/100g	2.1	8.36	16.45	29.51	44.97
Colour values:					
L	45.66	42.31	36.94	32.71	30.42
a	18.74	13.42	12.51	12.74	11.83
b	21.96	18.01	14.03	13.86	11.25

As can be seen, in all variants where additives have been applied, there was a slight decrease in the amount of proteins, an increase in the amount of insoluble dietary fibers and total phenolic compounds, and a corresponding increase in antioxidant activity was noted.

Deformation is calculated by multiplying the firmness by the gluten (internal stickiness). Chewability is calculated by multiplying the deformation by the elasticity (Table 11).

Table 11.
Texture indicators of cake products prepared with additives, n=6, p<0.05.

Experiment variants	Firmness	Internal stickiness	Elasticity	Deformation	Chewability characteristics
Control I	1240	0.492	8.250	610.08	50.33
II (1%)	1360	0.445	7.930	605.20	47.99
III (2%)	1420	0.484	7.645	687.28	52.31.
IV (3%)	1650	0.445	8.013	734.25	58.83
V(4%)	1710	0.451	8.302	771.21	64.03

The texture indicators of the cakes prepared with the utilization of additives have been studied on the first day. It has been found that as the amount of additives increased, the firmness of the cakes also increased. Initially, there was a slight decrease in elasticity, followed by an increase. Although the internal stickiness exhibited different values, it decreased with increasing amounts of additives. An increase in chewability characteristics was observed with increasing additive levels. Specifically, the chewability characteristic was 47.99 when 1% additives were used, and it increased to 64.03 when 4% additives were used.

The cake products prepared with the incorporation of additives have been re-analyzed after 3 days of storage (Table 12).

Table 12.
Texture indicators of cake products stored for 3 days, n=6, $p<0.05$.

Experiment variants	Firmness	Internal stickiness	Elasticity	Deformation	Chewability characteristics
Control I	1246.0	0.450	8.56	560.7	47.99
II (1%)	2861.3	0.415	8.05	1187.4	45.58
III (2%)	3025.2	0.413	8.59	1249.4	10.73
IV (3%)	3296.4	0.410	8.65	1351.5	11.69
V(4%)	3426.3	0.430	8.11	1473.3	11.94

As it can be seen, the amount of firmness has been characterized by higher indicators in the cake products stored for 3 days. Compared to the first day, after 3 days, a slight decrease in internal stickiness and chewability characteristics, and an increase in deformation properties have been observed. In this case, it can be seen that the elasticity underwent very slight changes.

6. Discussion of the Results of Studying the İmpact of the Application of Resource-Conserving Technologies on the Composition of Functional Food Product Samples

Wild rosehips have been harvested in different regions of Goygol, Dashkasan, and Gadabay, and juice and wine have been prepared. The pomace residues formed during processing have been used for recycling. For this purpose, the formed pomace has been spread out in the sun (protected from direct sunlight) to a thickness of 2-4 cm and fermented, then subjected to subsequent processing operations. Dry pomace obtained from one part of the rosehip pomace was ground and applied as pomace powder. Pomace extracts have been obtained from the other part of the pomace by applying different extractants and included in further studies as an additive.

Functional juice and wine have been prepared on the basis of rosehip and grape juices. In order to enrich the composition, extracts of rosehip obtained with distilled hot water have been utilized in the juices. To enhance the wine's composition, an alcoholic sour wine extract of up to 25-30% has been applied. The samples to which the extracts have been added were superior to the control in their harmonious taste, bright color, and high antioxidant capacity.

Different amounts of pomace powder have been used to produce functional yogurt and bakery products, and the optimal dose of its addition has been determined for each product.

The amount of sugars in the juice samples ranged from 9.01-10.22%, the amount of acids titrated to malic acid ranged From 1.01-1.12%, and the amount of ash ranged from 1.15-1.19%. No significant differences have been observed between the samples, and it has been found that it met the requirements for future juice and wine processing (Figure 1). The recipe mentioned below has been followed during the preparation of rosehip wine. To prepare 100 dal of rosehip wine, 166 kg of rosehip fruit, 1200 dm^3 of drinking water, and 234 kg of sugar have been mixed, and 0.47 kg of yeast, 0.1 kg of sulfite anhydride, and 0.3 kg of ammonium phosphite have been added as yeast feed. By carrying out the fermentation to the end (residual sugar 0.25-0.30%), sour wine samples were obtained. At this time, the highest alcohol content (12.7% by volume) was observed in the Dashkasan sample, and the lowest alcohol content (11.3% by volume) was observed in the Goygol sample. The Gadabay sample occupied an intermediate position with an alcohol content of 11.3% by volume (Figure 2 and 3).

A coupage asterisk was established for the preparation of wines with residual sugar based on the prepared sour wine and rosehip juice. In the samples of semi-sweet wine prepared by coupage, the mass concentration of sugars varied between 60.0-66.0 g/dm^3, residual extract 16.2-17.1 g/dm^3, 10.9-11.5 h% and the amount of volatile acids 0.36-0.48 g/dm^3. In this case, the highest alcohol content was in the Dashkasan sample, the lowest in the Gadabay sample; while the amount of residual extract was high in the Gadabay sample, it was lower in the Goygol sample. Based on the conducted studies, a process flow diagram for the preparation of semi-sweet wine from rosehip sour wine material has been prepared (Table 1 and Figure 4).

During the organoleptic evaluation of the prepared juice samples, it was found that the highest tasting score was achieved when the amount of rosehip pomace extract added was 7% (variant IV). Further increases in the amount of added rosehip pomace extract were observed to weaken the organoleptic quality (Table 2).

The amount of dry matter in the juice samples ranged from 24.7% to 26.5%, and the sugar content ranged from 20.4% to 23.0%. Compared to the control, the highest antioxidant capacity was observed in variant 5 with 10% added, reaching 91.5 μm Trolox/g. Although this variant exhibited the highest antioxidant capacity, in terms of organoleptic evaluation and other compositional indicators, variant 4, with 7% added pomace extract, was considered optimal (Table 3).

The amount of phenolic compounds in the wine samples also increased with the increase in the dose of added rosehip pomace extract. However, in terms of organoleptic quality, option 4, i.e., the utilization of 15% rosehip pomace extract, was distinguished by its superior value. That is, this option was rated 4 points higher than the control and 0.7 points higher than option 5, which added 20% rosehip pomace extract (Table 4).

In yogurt samples prepared using rosehip pomace powder, an increase in the amount of dry matter has been observed during storage, with an increase in the amount of additives. The pH indicator for the variants, including variant III, increased slightly in the control and previous variants, while a decrease in the indicator has been observed during storage in variants IV and V. During storage, there was a slight increase in the amount of titratable acids, a decrease in water retention capacity, and whey separation (Table 5).

In the control (variant I - without the addition of pomace powder), the amount of proteins was 3.07%, but with increasing the dose of the supplement, an increase in this amount was observed to some extent. In this case, in variant V, the amount of proteins was 3.20%. At the same time, an increase was also noticeable in other indicators. Interesting changes were also observed in the amount of phenolic compounds with an increase in the dose of pomace powder (Table 6).

As the amount of the additive increased, a regular increase was observed in the amount of phenolic compounds. The greatest increase was observed when 4% of the additive was applied, and this amount was 201.46 mg GAE/kg. However, according to other indicators of the composition and organoleptic properties, option IV was considered optimal (Figure 5).

The L value varied between 84.86-87.96, and the b value ranged from 1.36-2.30 across the samples. The lowest L value was observed in variant V, while the highest was in variant Control-I. Conversely, the b value showed the opposite trend. Variant IV was rated higher during organoleptic analysis, which was somewhat consistent with the results of the physicochemical analysis (Table 7 and Table 8).

During the research conducted for the preparation of bread-cake products utilizing rosehip pomace powder, the composition of the raw materials and additives used was first analyzed. It was found that, except for the amount of proteins, other compositional indicators were higher in a mixture of rosehip pomace powder than in flour, which is the main raw material. In particular, the pomace powder differed from flour in terms of the amount of fats, phenolic compounds, insoluble dietary fibers, and antioxidant activity (Table 9).

In all variants where additives have been applied, there was a slight decrease in the amount of proteins, an increase in the amount of insoluble dietary fibers and total phenolic compounds, and a corresponding increase in antioxidant activity was noted (Table 10).

A study of the texture parameters of cakes prepared with the incorporation of additives on the first day showed that as the amount of additives increased, the firmness of the cakes increased. At the beginning, a slight decrease in elasticity was observed, followed by an increase. Although the internal stickiness values varied, they also decreased with increasing amounts of additives. Chewability increased with increasing amounts of additives (Table 11). The 3-day-old cake products have been characterized by higher firmness. After 3 days, compared to the first day, a slight decrease in internal stickiness and chewability has been observed, while an increase in deformability has been noted. In this case, it can be seen that the elasticity underwent very little change (Table 12).

The results of the study have practical significance for the juice, wine, and canning industries. The findings can be utilized to produce juice, wine, and canned products with high antioxidant properties.

At the same time, the dose of pomace powder, determined by research in the production of functional yogurt and bread-cake products and other research results, can be used in the dairy and bakery industries, as well as in scientific research conducted in these areas, in family farms, and in relevant processing enterprises.

The study is acceptable for rosehips and red grape varieties. It is particularly limited for delicate juices and wines made from white grape varieties, which are less oxidized and protected from oxygen.

The drawback of the study is that the ripening time of wild rosehips, which grow in different conditions, often does not coincide with the ripening time of grape raw materials, and harvesting is carried out at different times, requiring specialized research and equipment. Future studies can be expanded to utilize rosehips and processing residues in the production of canned fruits and berries.

We consider it promising to study a number of issues addressed in the study, including changes in nutritional and antioxidant properties of raw materials and finished products during storage.

7. Conclusıon

1. Samples of juice and wine made from rosehips grown in three regions have been studied. Functional juice was prepared by adding 7% pomace extract to the juice blend of three aboriginal and introduced grape varieties, and functional wine was prepared by adding 15% wine-alcohol pomace extract to the wine sample. A process flow diagram and recipe for making wine from rosehips have been developed. In the samples of semi-sweet wine prepared by coupage, the mass concentration of sugars was 60.0-66.0 g/dm^3, residual extract was 16.2-17.1 g/dm^3, alcohol content was 10.9-11.5 h%, and the amount of volatile acids was 0.36-0.48 g/dm^3. The high alcohol content was noticeable in the Dashkasan sample, and the low content was noticeable in the Gadabay sample.
2. In yogurt samples prepared by utilizing rosehip powder, as the amount of powder increased, dry matter and titratable acidity increased, while water retention capacity and whey separation tended to decrease. The amount of phenolic compounds in stored yogurt samples increased proportionally to the increase in the amount of additives. The optimal dose of pomace powder, which enhances the antiseptic, antioxidant properties, and organoleptic quality of yogurt, was 3%.
3. In bread and cake samples prepared with the addition of rosehip pomace powder, a slight decrease in the amount of proteins, an increase in the amount of insoluble dietary fibers and total phenolic compounds, and an increase in antioxidant properties have been observed in all variants. An increase in firmness and chewability properties, an initial slight decrease in elasticity, then an increase, and a decrease in internal stickiness have been observed with

increasing amounts of additive. Samples stored for 3 days showed a slight decrease in internal stickiness and chewability properties, an increase in deformation, and a slight change in elasticity. The optimal dose of pomace powder that provides higher quality has been determined to be 2.5%.

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