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ABSTRACT

of the Dissertation submitted to receive the scientific degree of Doctor of Sciences

IMPROVİNG BEVERAGE TECHNOLOGY THROUGH THE USE OF HERBAL BİOLOGİCALLY ACTİVE ADDİTİVES DERİVED FROM PLANTS

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OVERALL QUALITY OF WORK

Relevance of the topic and degree of development. The increasing demand for high-quality and natural food products, including both non-alcoholic and alcoholic beverages, has led to significant developments and expansions in the food industry. In recent years, a discernible shift has occurred in the eating habits of individuals. The indifferent approach to this issue has been replaced by a health-oriented perspective, leading to increased consumer interest in natural products made from raw materials without artificial additives.

The emphasis on achieving a balanced and healthy diet has spurred the emergence of a new generation of food products referred to as "functional products." These products stand apart from traditional ones by not only providing nutrition but also reducing the risk of diseases associated with poor dietary choices. They contain functional food ingredients that positively impact the physiological functions of the human body.

Beverages, in particular, present a highly technological opportunity for the creation of new types of functional food products. The production process of beverages allows for the easy addition of new functional elements, and their lack of thermal processing enables the preservation of all beneficial substances. The industry is currently witnessing a wide range of innovative beverage options, which hold great commercial appeal. These options present opportunities to reduce production costs, enhance profitability, improve technical conditions, and provide relevant instructions.

The utilization of plant extracts in the production of both non-alcoholic and alcoholic beverages enhances their natural properties and expands the range of varieties incorporating these products. By deliberately selecting herbal raw materials in accordance with existing regulatory standards, substitution and safety considerations, it becomes possible to create specific functional beverages with increased biological value. Noteworthy contributions to this field have been made by scientists and specialists such as M.A. Nikolayev, V.A. Pomozov, M.V. Gernet, M.A. Polozhnikov, and Q.L. Fiolonov.

Numerous studies have focused on addressing commercial and technological challenges. However, the modern development in this field requires the solution of a number of issues at the level of new scientific and technical capabilities, the solution of a large-scale actual scientific problem such as the full realization of the potential of technology and technical equipment improvement.

Given the relevance of this subject, this research work focuses on the development of technology for preparing alcoholic and non-alcoholic functional beverages using physico-chemical and resource-saving biochemical methods, as well as utilizing herbal and biologically active raw materials.

Research goals and objectives. The research aims to establish an improved technology for non-alcoholic and alcoholic functional beverages that align with modern quality standards, utilizing plant-based biologically active substances and extracts. The following research tasks have been outlined to accomplish this goal:

- Justifying the selection of herbal raw materials as the bio-source, considering their recommended enzymatic complex composition and biologically active components.
- Substantiating the extraction regimes for water-alcohol extracts, ensuring a balanced composition through rational processing methods and an intensive extraction process. This includes extracting from oak and various local fruit trees.
- Developing regimes for producing distillate from grain malts.
- Providing technological and technical requirements for the implementation of intensive technologies in the production of alcoholic and non-alcoholic beverages using extracts derived from herbal raw materials and grain malts. Additionally, determining the economic viability of the experimental approach.

Research methods. The theoretical and methodological framework of this study draws upon the scientific contributions of both domestic and international researchers. To achieve the research objective, commonly accepted methods rooted in laboratory experiments, statistical analysis, and instrumental analysis were employed. Statistical methods were applied to analyze the data obtained from the experiments, utilizing software programs such as Statistics 10,

Mathematica 10, Mathcad 15, Microsoft Excel 13, and other relevant computer programs in accordance with contemporary practices.

The main provisions defended:

- Obtaining the herbal extracts, evaluating their quantitative and qualitative composition, and examining the beverages prepared using these extracts;
- determining the optimal parameters for obtaining cereal plant malts and evaluating the activity levels of the enzymatic complex involved in the process;
- developing a method to determine the diffusion characteristics of various sawdust materials and reporting on the extraction cycle time
- evaluating the impact of biologically active substances derived from herbal raw materials on the quality and biological value of both alcoholic and non-alcoholic beverages;
- creating mathematical models for the evaluation and prediction of beverage quality, as well as optimizing extraction processes from sawdust;
- evaluating the functional properties of powdered malt extract and powdered compound malt extract;
- designing a method for developing non-alcoholic functional beverages with a balanced composition and specific medical and biological properties. This approach is based on the utilization of herbal biologically active substances and extracts.

Scientific novelty of the research. A mathematical model was created to optimize the ultrasonic processing modes of different wood chips during the extraction process. Additionally, a method for determining the diffusion characteristics of wood material was devised. A physico-mathematical method was developed for powdering extracts obtained from malt and mixed malt. Through computer experiments, the optimal parameters for the primary mechanical, heat, and moisture exchange processes were determined. A comparative analysis of the structural-mechanical properties of powdered malt and mixed malt extracts was presented for the first time.

The scientific basis for biologically active substances of herbal origin was established, including a study of their cardiomonitoring indicators, antimutagenic properties, and adaptogenic properties.

The changes in the environmental composition and the impact of recipe components on fermentation during the preparation of beverages using the obtained extracts were examined.

The technologies for producing both non-alcoholic and alcoholic beverages using various herbal extracts and biologically active substances were scientifically justified. It was determined that the physico-chemical parameters of the extracts depend on the type of extractant, its concentration, and the extraction time. The research also revealed the patterns of changes in biologically active substances based on the extraction parameters and the raw materials used.

An evaluation system was developed to predict the quality and design of alcoholic beverages.

A mathematical model was devised for the production of non-alcoholic functional beverages, considering the balanced composition with essential micronutrients, amino acids, and macroelements.

Theoretical and practical significance of research. Theoretical knowledge about the regular presence of biologically valuable components in non-alcoholic and alcoholic beverages has been obtained. Technologies for new types of beverages have been developed based on various herbal extracts. Beverage recipes rich in biologically valuable components have been proposed. The economic benefit of the developed proposals is based on the use of natural ingredients and, depending on the recipe, amounts to 17,687 thousand AZN per 1,000 dal.

Approval and application of work. The results of the research work were presented at various scientific-practical conferences, including:

- Scientific-practical conferences of professors, doctoral students, and masters of the "Agrotechnology" faculty at Azerbaijan State Agrarian University (ADAU) in Ganja from 2017 to 2023.
- The 83rd International scientific conference of young scientists, graduate students, and students in Kiev in 2017.
- The III and IV Republican Scientific and Practical Conference organized by the Ministry of Education of the Republic of Azerbaijan and Azerbaijan State University of Economics (UNEC) in Baku from 2019 to 2020.

- The 85th International Scientific Conference of Young Scientists, Graduate Students, and Students in Kiev in 2019.
- The XIII International scientific and technical conference on Techniques and technology of food production in Mogilev in 2020.
- The All-Russian international internet conference on Modern biotechnology: current issues, innovations, and achievements in Kemerovo in 2020.
- The International Scientific-practical conference dedicated to the 98th anniversary of the birth of National Leader Heydar Aliyev at Azerbaijan University of Technology in Ganja in 2021.
- The Republican Scientific-practical conference held at the Institute of Microbiology of ANAS in Baku in 2022.
- The international congress of modern researches in social and human sciences in Shusha in 2022.
- The VI International Scientific and Practical Conference on "Development and management of the quality of agricultural products" at Belarusian State Agrarian Technical University in Minsk in 2023.

Additionally, the developed recipes based on the applied technologies were implemented in "Az-GRANATA" LLC (Appendix 1,2,3) and "Salyan Qida Mahsullari Istehsalat Kommersiya Shirket-leri" companies (Appendix 4,5), resulting in economic efficiency.

The name of the institution where the dissertation work was performed. Dissertation work was performed at the "Food products engineering and expertise" department of Azerbaijan State Agrarian University.

The total volume of the dissertation is indicated by noting the volume of the structural sections of the dissertation separately. The dissertation is structured as follows: it comprises an introduction, six chapters, conclusions, production recommendations, 253 references, and appendices. It contains 35 figures, 103 tables, and 6 appendices.

In terms of dissertation content, the introduction is 6 pages with 108,35 marks. The first chapter consists of 54 pages with 105,636 marks, the second chapter is 24 pages with 35,870 marks, the third chapter is 41 pages with 57,344 marks, the fourth chapter is 30 pages

with 47,347 marks, the fifth chapter is 50 pages with 79,063 marks, and the sixth chapter comprises 59 pages with 77,561 symbols. The results section covers 2 pages with 3,852 symbols, while the production recommendations occupy 1 page with 1,236 symbols. The list of references, containing 253 sources, spans 29 pages with 47,958 symbols.

The overall length of the dissertation is 300 pages of computer writing, amounting to a total of 473,967 characters (426,009 characters excluding the list of references and appendices).

CONTENTS OF THE WORK

In the introduction, the relevance of the topic, the setting of the problem and the general characteristics of the dissertation are given.

The first chapter is entitled "Analytical Overview," which discusses the problem of healthy nutrition in human nutrition, the current state of research on the use of functional food products, the analysis of the technological properties of biologically active substances in plants for both food and non-food purposes, the application of extracts in beverage technology, and the study of concentrated beverage technologies using non-traditional raw materials. The chapter also explores the effects of biologically active additives and the design features of functional beverages. At the end of the chapter, the goals and objectives of the research are presented.

The problem of balanced nutrition is particularly relevant today, as scientists have established a link between "diseases of civilization" such as obesity, hypertensive diseases, allergies, diabetes, various forms of immune deficiency, decreased infection tolerance, and other adverse factors, and eating disorders.

Non-alcoholic beverages hold great interest as they have the potential to be highly nutritious among the various food products consumed by the population. These beverages can be considered an optimal form of food product, enriching the diet of individuals with essential nutrients. Furthermore, biologically active substances have a positive impact on the body's functional state, metabolism, and immune system.

Increasing the nutritional and biological value of semi-finished dairy products, as well as expanding their range by adding processed fruits and berries, is important. It is known that biologically active ingredients of plant raw materials are quickly digested together with milk protein. In this case, the additives should be compatible with the milk base and give the finished product an attractive appearance. The theoretical and practical basis for creating products with a functional purpose and adjustable composition is reflected in the works of A.A. Pokrovski, A.M. Ugolova, N.N. Lipatova, U.A. Togova, V.M. Poznyakovski, and other researchers. Research in the field of dairy farming is documented in the works of P.F. Krashenina, A.V. Shalig, V.K. Gavrilova, I.S. Khamagaeva, L.V. Tereshuk, V.N. Sergeyeva, A.A. Mayarova, and many others.

Despite the insufficient raw material base of fruits and berries in our country, extensive complex processing of these resources has not been developed. One reason for this is the lack of modern, high-efficiency processing technology and suitable equipment. Another factor is the insufficient study conducted on these issues.

Scientific justification and the selection of primary raw materials and functional ingredients are of primary importance during the development of the technology.

The task of producers of enriched and functional food products is to ensure that the added biologically active substances, vitamins, and mineral substances do not compromise the consumption and medical-biological properties of the food. It is essential to guarantee that the product can be stored throughout its shelf life.

Traditionally, in the production of alcoholic beverages, oak wood is used to obtain distillate from stored grains. According to the literature, oak tannins contain 25% pyrogallic hydroxyl group, while procatechin and phloroglucin do not have a hydroxyl group. Oak hemicelluloses consist of pentazones, which make up to 23% of the dry mass of the wood. The main component of pentazones is xylon, which forms the majority of pentazones. Oak also contains galactan in a concentration of 0.3-1.3% (based on absolute dry matter) and a small amount of starch, up to 1.3% of the dry mass. The adhesive substance of oak has not been fully studied yet.

As mentioned earlier, the critical aspect in the creation of new food products is related to the functions of raw materials, their metabolism, demand, availability, and their impact on human health.

Biologically active components of plant raw materials include terpenes, polyphenol compounds, alkaloids, glucosides, phytohormones, as well as proteins, trace elements, and vitamins. Cereals and legumes are commonly used in beverage technologies. It is important to balance the aforementioned components, including wheat, barley, rye, corn, as well as alternative raw materials such as buckwheat and peas. Buckwheat serves as a gluten-free raw material, while peas provide a source of protein. Malt is prepared from these plants for further use in beverage technology.

Germinated grains, known as malt, are used as the main source of raw material to produce malt extract and grain distillate. Rye, barley, corn, and wheat are traditionally used in the production of malt extract, grain distillate, and beverages derived from them. Buckwheat and chickpeas are considered alternative sources of raw materials.

Legumes are a source of plant protein and amino acid nitrogen, which determine their suitability for use in the production of malt extract and food products. Chickpeas can be used in the mixture without malting, particularly in combination with wheat, barley, and oats malts. In this case, the lack of amylolytic and proteolytic activity of the latter is taken into account to obtain standard extracted juice during extraction.

With the implementation of new, more effective technologies, enterprise development involves increasing production by renewing the main assets through improved organization, better utilization of periodic assets, increased employee qualifications, and improved scientific labor organization. These efforts result in increased productivity, reduced material and labor intensity in the main production area, and ultimately contribute to increased income and profitability of the enterprise.

Intensive science-intensive technology in beverage production includes the application of specialized technological and biotechnological methods to achieve scientifically-based adjustments in raw material composition, predictable product outcomes, and compliance

with modern management systems for ensuring the safety of food products.

The quality of alcoholic and non-alcoholic beverages is influenced by the process regime and technological characteristics at each stage of production, necessitating scientific justification. The selection of plant raw materials, including alternative species, should be well-founded. Methods and regimes for malt preparation need to be developed, and the production of extracts as semi-finished products with controlled indicators should be optimized. It is important to consider the biochemical characteristics of microorganisms that affect the quality indicators of beverages. This includes the biosynthesis of metabolic products, characterization of fermentation products, beverage design methodology, evaluation of composition balance, approved functional composition, and safety.

The second chapter is called "Research object and methods". This chapter provides a comprehensive overview of the research objects, methods, parameters, and equipment used in the study. The objects of research encompassed various types of plant and mineral origin, dairy raw materials, biologically active plant-based additives, semi-finished products, and beverages prepared using these materials. Different technological schemes for their preparation were also considered.

The research involved the examination of plant raw materials from different varieties, including experimental alcoholic extracts derived from grape clusters, combs, and seeds. Grape oil obtained from both white and red grape varieties, as well as water-alcohol extracts of various fibers, were included as research objects. The study also encompassed the utilization of different technological methods, tools, apparatus, and devices.

In the development of alcoholic beverages, barley, rye, wheat, and corn were utilized. For non-alcoholic beverages, cereals such as barley, corn, buckwheat, and peas were employed. The research also incorporated enzyme preparations, including the amylolytic complex Thermozym 1000L (Bacillus liheniformis), Glucogam 500L (Aspergillus niger), and Visko Star 150L (Trixoderma longibranchiatum) for the hydrolysis of non-starch polysaccharides. It is

worth mentioning that all these enzyme preparations were approved for use.

The research further involved the study of various dry alcoholic yeasts, such as Sacch. Cer (Fermiol), race DY 7221, and dry brewer's yeast W 34/70 (imported from China and purified under suitable conditions). Additionally, the lyophilized biomass of Lactobacillus plantarum strain 8P-A3, preserved in a sucrose-gelatin medium, and dry bread yeast of the "saf-moment" trademark were investigated. Dry wine yeasts were also included as objects of research.

The research was conducted within the framework of the objectives established by the Department of "Food Engineering and Expertise" at the Azerbaijan State Agrarian University. The study took place in well-equipped laboratories, equipped with modern instruments and equipment capable of analyzing the chemical composition of beverages and extracts. These facilities facilitated accurate and reliable data collection and analysis for the research purposes.

The quality assessment of unmalted materials involved the evaluation of several indicators, including organoleptic properties, presence of other additives (littering), natural mass of the grain, relative humidity, starch content, protein content, and germination capacity (for grains intended for malting).

For purchased malts, the main physico-chemical parameters were analyzed. The amount of carbohydrates in candied juice was determined using the iodometric method, while the amount of amino nitrogen was measured using the "copper method".

The identification of aromatic aldehydes and phenolic acids was performed using the high-performance liquid chromatography (HPLC) method. This method involves the use of a device capable of mixing two solutions and equipped with a spectrophotometric detector to analyze the sample's optical density. In the case of tree extracts, the CF-46 spectrophotometer was used for monitoring. To analyze the presence of hall acids and vanillin in water-alcohol extracts and beverages, a microcolumn HPLC method was employed. The analysis was conducted using a Milichrome-4 M-Bondopak C_{18} (2x120mm) chromatograph with a particle size of 10 μm.

The total amount of inoculants in tree extracts was determined using the permanganatometric method. The amount of tannins with OH phenolic groups was measured using a conductometric method. The antioxidant activity of tree extracts was assessed using the "Tsvet Yauza-01-AA" analyzer. To determine the maximum extract yield from wood material, substances separated from the chips in a Soxhlet apparatus were weighed after drying. For assessing the diffusion characteristics of fruit trees such as cherry and plum, an experimental device consisting of a glass container with a stirrer inside was used. The container could be hermetically closed with a lid, and the mixer shaft was driven by an electric motor rotating at a constant speed of 300 rpm. Heat-treated wood samples in the form of discs (37.2 mm diameter, 6.0 mm thickness) were attached to the mixer shaft using washers. The samples were immersed in a water-alcohol solution contained in a collecting container with a volume of 450 cm^3, which contained 30-40% ethanol.

The processing of experimental data was carried out on a personal computer using software such as Microsoft Excel and STATISTICA, which utilize standard methods of probability theory and mathematical statistics.

During the direct measurements and indirect determination of parameters, the reliability probability was assessed by considering the share of the mean square error "σ" ρ and the accuracy "ε".

For independent studies, the standard deviation "σ" and Δ were calculated using standard statistical methods and the STATISTICA 6.0 software.

All experiments presented in the thesis were conducted with 3-4 replicates, and analytical determination of each sample was based on a minimum three replicates. The tables and figures provided represent typical values observed in the experiments. The mathematical expectation was calculated for each measured value, and the results were discussed in a manner that ensures reproducibility in each experiment. The deviation in each case did not exceed 3-5%.

The method of statistical analysis was applied to analyze the obtained values. The following statistical criteria were used in

processing experimental values: adequacy of the regression equation-Fisher's criterion.

The method of least squares was applied to determine pairwise dependenants between two quantities. When determining the optimal dosage of receptor components, the input factors and their variation intervals were taken so that they cover the range of interest and are evenly distributed within this interval.

The research program aimed to achieve maximum quality (y) and minimum costs (y2). Dependenants on the input factors that serve this purpose in the technical process were identified and incorporated into the response function (target function) as a linear combination of the first-degree factors:

$$y_1=b_0+b_1x_1+b_2x_2+b_3x_3+b_{12}x_1x_2+b_{13}x_1x_3+b_{23}x_2x_3+x_1x_2x_3 \quad (1)$$

$$y_2=b'_0+b'_1x_1+b'_2x_2+b'_3x_3+ b'_{12}x_1x_2+b'_{13}x_1x_3+b'_{23}x_2x_3+b'_{123}x_1x_2x_3. \quad (2)$$

Here b_0, b_{123}, b_0', $b_{1\,23}'$ is the corresponding regression coefficients with coded values in the equation.

To convert factors from their real values to coded form, the following formula is used:

$$x_i^k = \frac{x_i^n - x_{io}^n}{\delta_i}. \quad (3)$$

Here, x_i^k and x_i^n are the codified and natural values of the cofficient *i*, respectively; $x_{io}^n - i$ is the natural value of the factor at the level of zero (0); δ_i-*i* is the natural value of the variation interval of the factor.

The processing and evaluation of the obtained experimental values involved several steps. The calculation of regression coefficients followed these formulas:

- for the intercept:

$$b_0 = \frac{\sum_{j=1}^{N} y_1}{N}; \quad (4)$$

- for linear factors:

$$b_i = \frac{\sum_{j=1}^{N} x_{ij} y_i}{N}; \quad (5)$$

- for interaction factors:

$$b_i = \frac{\sum_{j=1}^{N} x_{ij} x_{qj} y_i}{N}. \quad (6)$$

Here $\bar{y}_i$ – "m" is the average numerical value of the output parameters for the j-type experiment in repetition; N – the number of experiments; $x_{ij} - j$ is the value of the i-factor in the experiment; $x_{qj} - j$ is the value of the q-factor in the experiment.

Taking into account that some regression coefficients can be taken too small, their significance level is checked.

The regression coefficient is considered significant if its value is greater than the absolute value of the confidence interval. When using a factorial experiment, the confidence intervals are equal for all coefficients. The significance of a coefficient is determined using the Student's criterion (t):

$$t = \frac{|b_i|}{\delta_{bi}}. \quad (7)$$

Here: $|b_i|$ – absolute value of i-coefficient of regression; t – Student's criterion value at the selected level of significance; δ_{bi} – the squared error of the regression coefficient. is compared with its tabular value $t_{tab}(0.05; f_y)$.

Here: 0.05 – the level of significance of the study; f_y - the number of degrees of freedom of the experiment.

$$f_y = N(m-1). \quad (8)$$

Here m_j – the number of repetitions in the experiment.

The selected variance of the regression coefficient to determine the squared error (is determined by the following formula: δ_{bi})

$$\delta^2_{bi} = \frac{\delta^2_y}{N}. \quad (9)$$

Here δ^2_y is the recovery dispersion.

$$\delta^2_{bi} = \sum_{j=1}^{N} \frac{\delta_j^2}{N}. \quad (10)$$

Here $\delta^2_j - j -$ the variance during "m" repetitions in the experiment.

$$\delta_j^2 = \frac{\sum_{k=1}^{m} (y_1 - \bar{y}_l)^2}{m-1}. \quad (11)$$

Here $y_j - j$ is the value of the output parameter in the experiment.

The reproducibility of the model is characterized by the homogeneity of the variances of the experiments. Homogeneity of variance is assessed using the Cochrane criterion ($G_{\max}$).

$$G_{\max} = \frac{\delta^2 j \max}{\sum_{j-1}^{N} \delta_j^2}. \quad (12)$$

If the calculated value of the criterion $G_{\max}$ is smaller than the table value $G_{jd}(0.05; f_N; f_u)$, then the hypothesis of homogeneity is accepted. Here, f_N is the number of free values of impulses; f_u the number of degrees of freedom of each estimate.

$$f_u = N(m-1). \quad (13)$$

Regression equations are tested for adequacy (the ability to accurately express the response surface).

The Fisher's criterion (F) is used to evaluate the adequacy of the model. This criterion δ_a^2 is determined by the ratio of the dispersion of adequacy to the dispersion of recovery (error of experiment) δ_y^2:

$$F = \frac{\delta_a^2}{\delta_y^2}. \quad (14)$$

Adequacy dispersion is calculated by the following formula:

$$\delta_a^2 = \frac{\sum_{a=1}^{N} (y_j - y_{jT})}{N-a}. \quad (15)$$

Here $y_j - j -$ the average value of the optimization parameter during iteration "m" in the experiment; $y_{jT} - j -$ the average value of the optimization parameter calculated by means of the regression equation for the experimental conditions; a – the number of determined coefficients of the model.

The obtained value of the Fisher's criterion is compared with the value in table $F_{tab}(0.05; f_a; f_y)$ where f_a is the number of degrees of freedom of the recovery variance:

$$f_a = Na. \quad (16)$$

If $F<F_{tab}$ is true, the hypothesis of adequacy is accepted with 95 % probability, indicating that the obtained regression equation accurately represents the experimental results.

The third chapter is entitled "Investigation of Technologies for Obtaining Plant Extract Materials." It reflects the modeling of the extraction process of wheat, barley, and rye malt and the optimization of variable factors, as well as the extraction process from powdered malt and polymalt extracts, and the application of ultrasound in extraction.

A 3^3 full factorial experiment was conducted to study the prediction and optimization of the wheat malt germination process and the interaction and significance of the influencing factors. The variable factors chosen were germination time (τ), wetting degree (W), and process temperature (t).

The following were taken as the response function of the experiment:

- amylolytic activity (AA) of enzymatic complex of malt, measured in W-K units;

- saccharifying ability (SA) of malt**,** measured in units/g.

The variation ranges of the units of the plan are given in Table 1.

Table 1. Variation limits of active experimental factors for obtaining wheat malt

Planning images	τ, per day	w, %	t, °C
Basic level, (0)	6	42	16
Variation interval, Δ	1	2	2
Level Up (+1)	7	44	48
Low level (-1)	5	40	14

The planning matrix of the experiment is given in Table 2.

According to the experimental values of Table 2, regression coefficients were obtained for the approximation of SA and AA values of wheat malt using the method of leaset squares. The adequacy of the coefficients was tested using the Fisher criterion in regression analysis, their significance level was tested using the Student criterion, and the

homogeneity of parallel experiments was tested using the Cochran criterion.

Table 2. Planning matrix and experiment results

Experiment No.	Code symbol of factors			The size of the factors			$У_{AA}$, W-K units	$У_{SA}$, $\frac{units}{g}$
	Z_0	Z_1	Z_2	τ, per day	w, %	t,°C		
1	-1	-1	-1	5	40	14	246.7	4.16
2	0	-1	-1	6	40	14	225.8	4.26
3	1	-1	-1	7	40	14	226.4	3.77
4	-1	0	-1	5	42	14	253.6	4.23
5	0	0	-1	6	42	14	287.8	4.78
6	1	0	-1	7	42	14	242.5	4.04
7	-1	1	-1	5	44	14	251.4	4.13
8	0	1	-1	6	44	14	275.8	4.60
9	1	1	-1	7	44	14	221.5	3.69
10	-1	-1	0	5	40	16	266.3	4.44
11	0	-1	0	6	40	16	268.5	4.48
12	1	-1	0	7	40	16	262.6	4.38
13	0	0	0	5	42	16	326.4	5.44
14	1	0	0	6	42	16	345.7	5.76
15	-1	0	0	7	42	16	276.7	4.61
16	-1	0	0	5	44	16	277.4	4.62
17	0	0	0	6	44	16	282.7	4.71
18	1	0	0	7	44	16	268.5	4.48
19	-1	1	1	5	40	18	231.5	3.86
20	0	1	1	6	40	18	250.4	4.17
21	1	1	1	7	40	18	228.7	3.81
22	-1	1	1	5	42	18	242.7	4.55
23	0	1	1	6	42	18	275.6	4.59
24	1	1	1	7	42	18	235.8	3.93
25	-1	1	1	5	44	18	244.6	4.1
26	0	1	1	6	44	18	253.8	4.23
27	1	1	1	7	44	18	230.5	3.84

The calculated value of Fisher's criterion (F_{rep}=27.66) is 9.8 times greater than the table value (F_{tab} =2.82). This provides a basis for

accepting the hypothesis of the adequacy of the regression coefficients to the experiment. The critical value of the Student criterion is t_{cris}=1.72. Thus, it can be concluded that the dimensional regression equation SA adequately expresses the dependence of wheat malt on the germination process. After removing statistically insignificant coefficients, the regression equation is as follows:

$$Y_{SA}=-2.452\cdot10^3+4.5\cdot10\tau-0.39\tau^2+4.880t-19.450w-0.113w^2. \quad (17)$$

According to the regression table model, SA the largest value of (5.35) τ=5.8 days, w=42.2%, t=15.9°C values. From the maximum experimental value (SA =5.76, τ=6 days, w=42%, t=16°C) makes the difference – 7.1%. The residual variance is = S^2_{var} 0.37 (unit/g)^2 according to the equation, with = 0.036 units/ Δy_{SA}g.

It is possible to draw the following conclusions about the effect of the studied factors on the quantity of SA:

- SA is most affected by germination temperature, secondly by wetting degree and thirdly by germination time;

- all these three factors on the quantity of SA is not linear. This is also shown by the large value of Student's criterion for coefficients with quadratic limits;

- none of the coefficients responsible for the combined effect of the factors was statistically significant, the effect on the quantity of SA is insignificant.

The calculated value of Fisher's criterion (F_{calc}=10.44) was 4.2 times larger than the table value (F_{tab}=2.49), which supports accepting the hypothesis of adequacy of the regression equation to the experiment. The critical value of the Student's criterion (t_{cris}=1.74) was used to identify statistically insignificant coefficients. The estimation of the statistically significant coefficients of the regression equation after removing the insignificant coefficients is presented in Table 3.

Table 3. Variation limits of factors

Planning conditions	τ, day	W, %	t, °C
Basic level (0)	7	43	18
Variation interval	1	2	2
Level Up (+1)	8	45	20
Low level (-1)	6	41	16

Here, the reported value of Fisher's criterion was F_{rep} = 24.11, which is 8.6 times higher than the table value (F_{tab} = 2.82), providing a basis for accepting the hypothesis of adequacy of the regression equation to the experiment. The critical value of the Student's criterion is t_{rep} = 1.72. Thus, it can be concluded that the dimensional regression equation adequately represents the relationship between the AA amount and the wheat malt germination parameter. After removing the statistically insignificant coefficients, the regression equation is expressed as follows:

$$y_{AA} = -1{,}357 \cdot 10^{4} + 2{,}975 \cdot 10^{2}\tau - 25{,}470\ \tau^{2} + 3{,}086 \cdot 10^{2}\,t - 9{,}645t^{2} - 5{,}023 \cdot 10^{2}\,w - 5{,}980w^{2} \quad (18)$$

According to the regression model of the table, the largest value of AA corresponds to (320.0) τ=5.8 days, w=42.2% and t=15.9 °C values. Its difference from the maximum experimental value (AA=345.7, τ=6 days, w=42%, t=16 °C) is 7.4%. The residual variance is estimated as S^2_{var}=148(W-K)^2, where Δy_{AA} - 23.8 units of W-K.

It is possible to draw the following conclusions about the effect of the studied factors on the quantity of AA:

- AA quantity is most affected by germination temperature, second by germination time and third by wetting degree;

- the effect of all three factors on AA quantity is not linear. This is proven by the presence of quadratic limits and the large value of Student's criterion for coefficients;

- none of the coefficients responsible for the combined effect of the factors is statistically significant, which indicates that they have a slight effect;

- the last two criteria also apply to the amount of SA of wheat malt.

According to this criterion, the optimization result of wheat malt extraction process is as follows:

τ=5.8 days, w=42.2%, t=15.9° C; y_{SA} =5.35, y_{AA} =320.0.

The reported values were 7% less than the maximum experimental values (y_{SA}=5.76, y_{AA}=345.7). A=1 was assumed during the optimization. The minimum and maximum values of the response functions were taken according to the experimental values.

The barley and rye malting process is modeled similarly to the wheat malting process.

The result obtained is as follows:

For barley malt: τ=6.1 days, w=44.1%, t=17.6^{0}C; y_{SA} =4.93, y_{AA} = 255.2. For rye malt: τ=4.6 days; w=45.1%; t=15.0^{0}C; y_{SA} = 2.63. A=1 was assumed during the optimization.

Data on the optimization of the process of obtaining malt is given in Table 4.

Table 4. Final data on the optimization of the process of obtaining malt

Grain type	Barley	Wheat	Rye
Optimum values of influencing factors			
Germination period, days	6,1	5,8	4,6
Degree of wetting, %	44,1	42,2	45,1
Germination temperature, ℃	17,6	15,9	15,0
Report value of quality criterion of malt			
SA, units/g	4,93	5,35	8,63
AA, W-K units	255,2	320,0	198,1

As can be seen from the table, grains differ from each other in terms of germination time, degree of wetting and germination temperature. Thus, the highest germination period is observed in barley- 6.1. days, and the lowest in rye -4.6 days. Rye has a high wetting rate of -45.1%, but it germinates at the lowest temperature -15℃. Compared to other samples, barley germinates at a higher temperature- 17.6℃.

Fig. 1 shows the temperature dependence of AA and SA for barley malt. These demonstrate that the reported results with regression equations are little different from the experimental values (points) before and after removing the statically insignificant coefficients (curves 1 and 2).

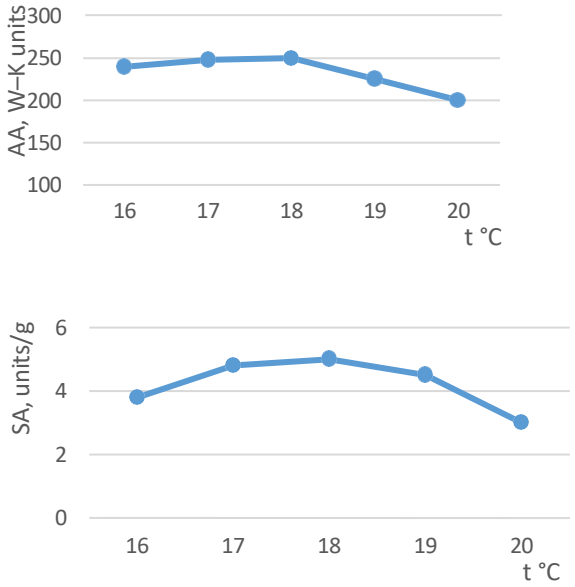
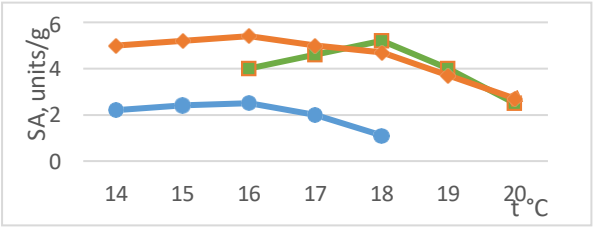


Fig. 1. Dependence of the AA and SA indicators of barley malt on temperature: a – the temperature dependence of amylolytic activity of barley malt; b – the temperature dependence of saccharifying activity of barley malt (τ=6 days; W=45 %)

Fig. 2–4 show the reported results obtained by regression equations with statically insignificant coefficients (not removed) for all studied malt varieties (1 – barley, 2 – wheat, 3 – rye). Report values are compared with experimental values (o – barley, ◊ – wheat, □ – rye).



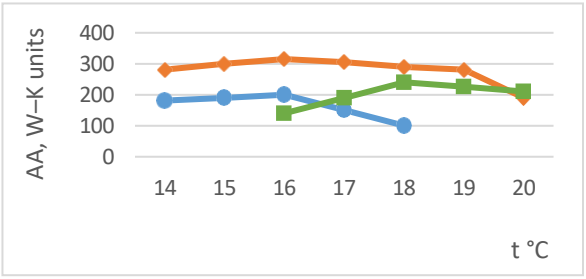


Fig. 2. Dependence of the AA and SA parameters of the studied malts on temperature: *a* – dependence of the saccharifying activity parameters of the studied malts on temperature; *b* – dependence of amylolytic activity of the studied malts on temperature: (τ=6 days; W=45 %-barley), (τ=6 days; W=42 %-wheat), (τ-5 days, W=44 % with rye): experimental points: o–barley, ◊–wheat, □–rye

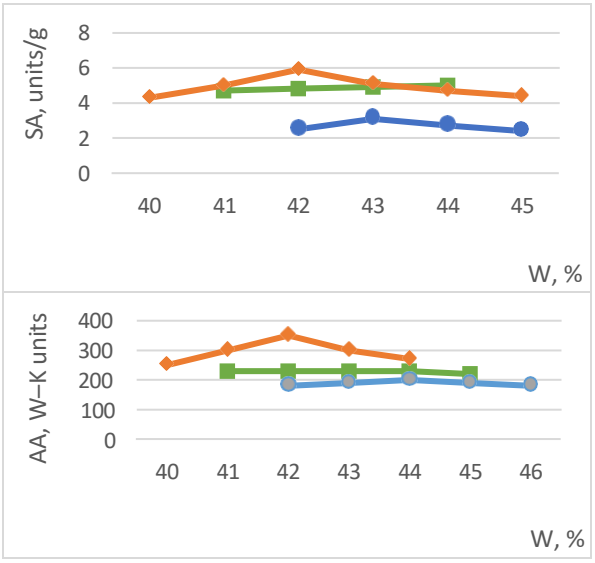


Fig. 3. Dependence of AA and SA indicators of the studied malts on wetting degree: a – dependence of the saccharifying activity indicators of the studied malts on the wetting degree; b–dependence of the amylolytic activity indicators of the studied malts on wetting degree. (τ=6 days; t=16 ℃-rye): experimental points: o – barley, ◊ – wheat, □ – rye

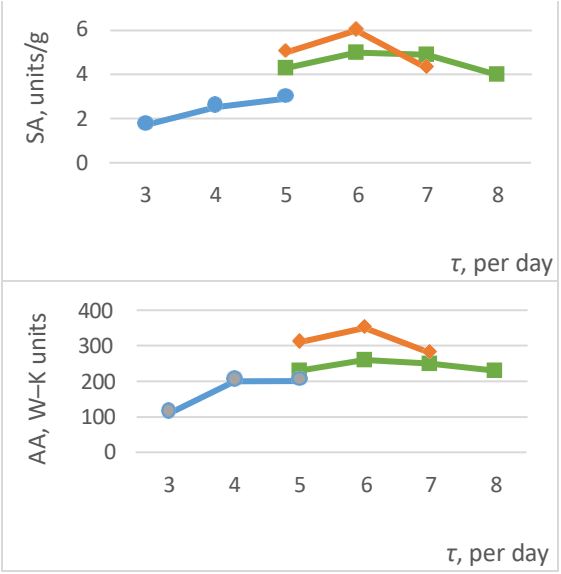


Fig. 4. Dependence of the AA and SA indicators of the studied malts on germination period: *a* – dependence of the saccharifying activity indicators of the studied malts on germination period; *b* – dependence of the amylolytic activity indicators of the studied malts on germination period (w=45 %; t=18 ℃-barley); (w=42 %; t=16℃ wheat); (w=44 %; t=16℃ – rye): experimental points: o – barley; ◊ – wheat; □ – rye

The analysis of the obtained dependencies shows that the germination temperature of barley, wheat and rye has the maximum effect on the complex amylolytic enzymes of malts.

In increasing the variety of non-alcoholic beverages with functional properties, it is of great interest to make polymalt and non-traditional grain and bean sprouts, to grind them into powder and to prepare beverages based on them. In this regard, the researches we conducted on barley, wheat and rye were similarly conducted on buckwheat, corn and peas. The optimal process values for buckwheat malt are as follows: τ=6 days, w=44%, t=15.6^{0}C.

When preparing powdered malt and polymalt extract, the juicing and brewing methods were applied together in order to ensure the normative indicators of the process in order to operate a rational crushing mode.

Different malt compositions were chosen in the fol- lowing ratios to broaden the variety of malt and polymalt extracts: sample 1 (three-component powdered polymalt extract TDE-1) – buckwheat: corn: barley – 1:1:1; sam- ple 2 (three-component TPE-2) – buckwheat: peas: bar- ley – 1:1:1; sample 3 (powdered buckwheat malt extract TQSE); sample 4 (powdered peas malt extract TNSE).

The juice obtained with an initial dry matter concen- tration of 15–16 % was evaporated in a vacuum drying cabinet (SPT-200) at a concentration of 0.025–0.030 MDa air and at a temperature of 50–60 °C to a dry matter con- centration of 35–40 °C. The material was then spray-driedin optimal modes.

Currently, most of the food ingredients we use are imported. Obtaining extracts from local herbal raw materials and its scientific-technological support are of great importance.

The solution of complex theoretical and practical issues is required to improve the existing scientific work on improving the technology of alcoholic beverages based on grain distillates stored together with wood shavings. The application of new technological methods is based on the development of rational modes of extraction of alternative wood materials.

The feasibility of applying a special processing method to wood materials for the purpose of intensifying extraction has been studied. In this study, scraps of branches from non-traditional local fruit trees such as quince, cherry, and cherry were used.

Wood shavings with dimensions of (size 20.0x14.5x0.9 mm) were kept in a hermetically sealed glass container for 18 days using the cycle method (at the of 3 g of wood shavings per 100 sm^3) of solution. The research was conducted at temperatures of 25, 30, 35, and 40°C.

One important factor is the pre-treatment of the wood material, as it influences the formation of organoleptic properties of extracts and alcoholic beverages.

In this regard, thermal processing of wood shavings through roasting was performed. During this process, two main outcomes were achieved: firstly, an increase in the specific surface area due to the breakdown of certain organic components of the wood particles, and

secondly, the acceleration of the hydrolysis process of lignin accompanied by the formation of aromatic aldehydes. The method involved a combination of known roasting techniques, followed by washing in hot water and drying.

After roasting the shredded wood material for 15 minutes at a temperature of 230 °C, it was washed in water at (75°C) to remove mechanical impurities and primary tannins, and then kept in water for 24 hours. The wood samples were subsequently dried at temperatures ranging from 110-130°C for 24 hours.

Optimal conditions for roasting were selected based on the amount of vanilla in the extract and organoleptic indicators as the main evaluation criteria.

The conducted studies revealed the dependence of the optical density value of the extracts on the extraction time. The research was carried out using different concentrations of ethanol in the solution, ranging from 20% to 60%. The optical density value of the extracts increased over a period of 16 days and remained stable thereafter (Figure 5).

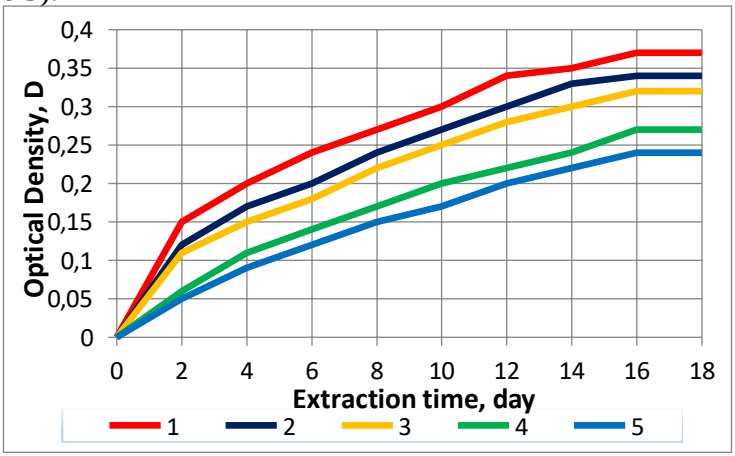


Figure 5. Dynamics of changes in the optical density of extracts at different concentrations of ethanol during the storage process. Share of ethanol in the solution: 1-60%; 2-50%; 3-40%; 4-30%; 5-20%

The dependence of the amount of inoculants in the extracts on the volume fraction of ethanol in the solution at different extraction temperatures was determined

The maximum amount of inoculants was observed at a temperature of 45^0C in a solution with a volume fraction of ethanol alcohol of 50%. 45-50% volume share of ethanol alcohol in the solution is considered a rational parameter for extracting tannin from wood material.

At a temperature of 45^0C (volume fraction of ethanol 50%), the amount of inoculants in the extract increased by 0.08 g compared to that obtained at 25^0C. The concentration of ethanol in the solution changes during extraction due to evaporation and impregnation processes. Table 5 shows the dependence of the volume fraction of ethanol on the extraction temperature regime.

Table 5. Volume share of ethanol in extracts depending on storage temperature, %

Temperature, ^{0}C	10	20	30	40	50
Volume fraction of ethanol, %	50.48	49.88	49.47	48.83	46.10

As the temperature increases, the amount of ethanol in the extracts decreases due to the intensification of evaporation and absorption processes. At 30^0C temperature, the decrease of ethanol content was 0.01 h%, and at 50^0C temperature it was 4.38 h%. The temperature dependence of the amount of ethanol in the solution can be used for the technological report of the value of the loss of ethyl alcohol. In order to reduce the loss of ethanol in the extraction process, it is more appropriate to conduct the process between temperatures of 20-30^0C.

Due to the fact that maturation of distillate during storage with wood material is related to the oxidation of compounds in wood pores, the indentation-protrusion of the top layer of the material on the alcohol-affected surface creates favorable conditions for the interaction of the components.

The application of ultrasound is considered one of the most prospective methods for intensifying the extraction of herbal raw materials. Due to the effect of ultrasound waves, the boundary diffusion is disturbed, the penetration of the extractant into the material becomes easier. As a result, the raw material swells faster, and turbulent and eddy currents are created. These help mass transport and dissolve substances. Even the intensive displacement of the intracellular material takes place, which intensifies their transfer from the raw material to the extractant.

Oak shavings were prepared, a water-alcohol solution with 50% volume share of ethanol was taken as an extractant, the ratio of 30 g of raw material-extractant to 1 dm^3 shavings was provided. Samples were taken for examination at intervals of 30 minutes in a spectrophotometer during ultrasound treatment with a frequency of 22-44 kHz and an intensity of 0.5 w/cm^2. The extracts were sonicated for 10-15 hours and affected for 5-15 minutes every 30-60 minutes. The control experiment is to periodically release juice without using ultrasound. The dynamics of changes in the optical density of the extracts are given in table 6.

Table 6. Variation of the optical density of the extracts depending on the ultrasound processing

Processing methods	Extraction time, hours/days				
	2	4	6	8	10
Periodic storage, day (control)	0.15	0.21	0.28	0.34	0.37
When processing at a frequency of 22 kHz/h	0.15	0.20	0.28	0.34	0.37
When processing at a frequency of 44 kHz/h	0.15	0.19	0.25	0.30	0.33

With the application of ultrasound, the extraction time is shortened by 25 times compared to juicing cycle. A comparative analysis of the main physico-chemical parameters of extracts obtained from oak shavings with and without ultrasound (control) was carried out (table 7).

Table 7. Comparative evaluation of raw and ultrasonically processed extract parameters

Processing methods	Carbohydrates, g/dm^3	Total extract, g/dm^3	Inoculants, g/dm^3	Halic acid, g/100 cm^3
Periodic storage, day (control)	0.34	2.60	1.82	1.14
When processing at a frequency of 22 kHz/h	0.46	2,82	1.91	1.45
When processing at a frequency of 44 kHz/h	0.48	3.10	2.06	1.41

Regardless of the frequency, the amount of carbohydrates increased by 38% compared to the control, the amount of total extracts increased by 8.5% when the ultrasound frequency was 22 kHz, and 19% when the frequency was 44 kHz. When exposed to 44 kHz frequency, the amount of inoculants increased by 5.13%.

The increase of total extract and inoculants during ultrasound application is related to heating effect, cavitation and displacement in liquid phase.

The amount of aromatic aldehydes in the extracts decreased when affected by ultrasound. This is due to the formation of insoluble precipitates and their condensation with the formation of corresponding acids**.**

Due to the mechanical destruction of wood shavings and the appearance of finely dispersed suspended particles in the process of ultrasonic treatment, the organoleptic indicators of the extracts decreased.

The purpose of the conducted experiments was to build a mathematical model for the optimization of the parameters of ultrasonic processing (the maximum extraction time by passing from wood shavings to the solution). In the mathematical model, the effect of several parameters on the thickness of the diffusion layer was considered: the speed of displacement of particles due to ultrasonic dispersal, the effect on the duration of the extraction process. Also,

with the help of a mathematical model, the stationary distribution conditions of the concentration of extractive substances in the thickness of the diffusion layer were determined.

Experimental verification of the mathematical model led to several conclusions: disintegration of the surface layer of the particle causes a significant (25 times) increase in the extraction rate; the speed of dispersal of the surface layer has a significant effect on the distribution of the concentration of the extract substance in the wood chip particle; at a sufficiently high rate of disintegration of the surface layer and the continuity of the ultrasound effect, the distribution occurs stationary. The ultrasonic extraction process was optimized at a frequency of 30 kHz: 15 minutes every hour for 1 hour.

The fourth chapter is entitled "Investigation of the use of residual resources for biologically active and extractive substances." This chapter explores the process of obtaining biologically active substances from grain residues, the extraction of oil from pomegranate seeds, the study of grape seed extracts, and the investigation of extractive substances in non-traditional plant seeds such as mung bean and horsetail. The study also examines the sprouts of bean seeds.

The extraction of new biological ingredients and biologically active substances from secondary raw materials, such as bran formed during cereal processing, is a relevant scientific issue awaiting a solution.

Research has revealed that wheat and rye bran serve as cell wall materials and contain valuable macronutrients such as protein, starch, and dietary fiber. They also contain antioxidant phenolic acids, flavonoids, polyphenols, and other compounds.

The chemical composition of bran varies depending on the wheat variety, cultivation conditions, and processing methods. The protein content ranges from 15.10% to 15.20%, lipids from 3.40% to 3.60%, starch from 25.40% to 26.10%, dietary fiber from 39.20% to 39.40%, and polyphenols from 3.61 mg/g to 3.69 mg/g. Consequently, bran has significant potential for application in food products. However, the fact that the bran produced in our country is not being utilized for this purpose poses a problem.

The selection of enzymes for bran hydrolysis is determined by the specific objectives. The concentration of enzymes plays a crucial role in the speed of enzymatic reactions. The initial rate of enzymatic reactions depends on the enzyme concentration and reaches its maximum enzymolysis rate at the saturation concentration of the substrate.

Table 8 displays the monosugar content of bran before and after enzyme treatment.

Table 8. Effect of enzyme treatment on the monosugar content of bran (by absolute dry matter, in %)

Type of bran	Monosaccharides									
	Arabinose		Galactose		Glucose		Xylose		Mannose	
	before processing	after processing	before processing	after processing	before processing	after processing	before processing	after processing	before processing	after processing
Wheat	7.1	14.1	0.7	1.0	21.2	24.1	14.8	13.5	0.2	0.0
Rye	6.5	13.0	0.8	1.1	8.6	10.3	22.7	18.6	0.0	0.0

The results show that the enzyme treatment led to an increase in the amount of monosugars. In wheat bran, the amount of arabinose increased from 7.1% to 14.1% after processing, while in rye bran it increased from 6.5% to 13%. However, there were reductions in quantity after xylose treatment, with a decrease of 1.3% in wheat bran and 4.1% in rye bran. Mannose was only found in wheat bran before processing.

Oils obtained from fruit seeds have a special place among vegetable oils. In different countries of the world, oils obtained from seeds are included in the composition of various dietary foods. The presence of all groups of glycolipids in many seed oils makes them a source of unsaturated fats that are considered beneficial in dietary supplementation. They are a source of rich fatty acids and fat-soluble bioactive elements.

There is a lot of oil in the dry seeds of pomegranate, it is possible to buy 72 tons of pomegranate oil per year from the existing seed waste.

5 g samples are homogenized in methanol (50 ml) in a blender for 1 minute. After that, 100 ml of hexane is added and homogenized for 2 minutes. After filtration, the liquid was dissolved in a 2:1 mixture of hexanemethanol (100 ml + 50 ml). In addition, it was homogenized again for 3 minutes and washed with fresh solvent (150 ml) passed through a filter. The mixed filtrate was purified again by adding 0.2 volume of 0.75% sodium chloride solution. All were mixed without shaking, and the layers were separated so that the hexane completely covered them. The purified lipids were collected in a vial and treated with sodium sulfate to remove residual moisture. After filtration, the extract was dried in a rotary evaporator at 40°C. The extracted fat (total lipids) was weighed and stored in hexane at 20°C.

The fatty acid content of the oil was analyzed as methyl ester. Each 0.1 g sample of oil was etherified using a mixture of 25 ml of sulfuric acid (98%) and 500 ml of methanol (94.8%) at a temperature of 80°C for 120 minutes. The resulting methyl esters were extracted in 10 ml of hexane and the extract volume was reduced to 0.5 ml in a nitrogen environment to prevent oxidation of unsaturated fatty acids. Gas chromatography analysis was then performed using a Shimadru gas chromatograph (GC-14 A - Japan) with methyl esters of fatty acids. Standard fatty acids were etherified using trifluoride (10% methanol solution). A 1 ml sample was applied to a film with dimensions of 80mm x 0.25mm x 0.2 mm. The temperature in the injector and detector was raised to 100°C, and the device was programmed to increase the temperature by 5°C per minute up to 175°C, followed by a hold at 220°C for 10 minutes.

The amount of each fatty acid was determined by comparing the peaks in the graph with the standard peaks containing methyl content.

The study of pomegranate seed oil revealed that it contains 95% total lipids based on dry matter. The composition of these lipids is predominantly composed of unsaturated fatty acids, which account for 63.84% of all fatty acids. Among the unsaturated fatty acids, oleic acid is the most abundant at 40.4%, followed by heptadecene at 10.4%, linoleic acid at 10.0%, palmitolein at 1.93%, φ-linolein at 1.01%, and linoleic acid at 0.10%.

In contrast, saturated fatty acids make up 36.3% of the total lipids in pomegranate seed oil. The predominant saturated fatty acids are palmitic acid at 20.7% and stearic acid at 14.8%. A small amount of margaric acid (0.12%) and began acid (0.64%) were also observed in the oil of pomegranate seeds. It is noteworthy that previous studies conducted by Arab, Spanish, and Iranian scientists did not report the presence of these acids. The lower oil content in Azerbaijani pomegranate seeds compared to other sources may be attributed to the fact that the studied material was used after a long period of storage (7-9 months).

The ratio of saturated to unsaturated fatty acids in the studied raw materials, including pomegranate seed oil, was found to be 0.57:1. This ratio is consistent with Spanish pomegranate varieties, which have a ratio of 0.44:0.51. The total lipid content of the pomegranate seed oil also aligns with the values reported by Spanish authors. The fat content in sweet pomegranate varieties ranges from 63 g/1 kg to 122 g/1 kg, while in sour varieties, it falls between 51-152 g/1 kg. However, these indicators do not match the information provided by Iranian authors.

In the analysis of pomegranate seed oil, a fractional analysis of sterols and tocopherols was performed using gas chromatography. The results showed that pomegranate seed oil contains 2.27% sterols and 0.37% vitamin E in various forms. Among these, the concentration of β-sitosterol and δ-tocopherol was found to be higher. These findings highlight the potential of pomegranate seed oil as a source of valuable biologically active substances.

During grape processing, various organic wastes are generated, which contain significant amounts of trace elements and biologically active substances. The skin of red grape varieties is particularly valuable as a secondary raw material due to its natural phenolic components, such as anthocyanins, phenolic acids, flavonoids, and other biologically valuable substances. Numerous scientific studies have focused on the composition and utilization of viticulture recycling products. To facilitate the practical use of these byproducts, it is important to study their component composition and explore their

applications in beverages. The specific results of the research conducted in this direction are presented in Table 9.

Table 9. The amount of dry matter and iron in the extract depends on the state of the cluster and the extractant applied

Grape variety	Cluster condition	Extractant	Amount of dry matter in liquid extract, %	Amount of iron, mg/kg
Saperavi	Sweet	Water	8.7	1.1
Saperavi	Sweet	0.5% hydrochloric acid	7.5	0.4
Merlot	Screamed	Water	4.7	2.4
Merlot	Screamed	0.5% hydrochloric acid	5.4	2.2
Cabernet Sauvignon	Boiled dry	0.5% hydrochloric acid	3.5	2.6
Cabernet Sauvignon	Sweet	Water	9.8	2.5
Cabernet Sauvignon	Sweet	0.5% hydrochloric acid	14.9	0.4

In order to prepare water and acidic extracts, the grape cluster was contacted with the extractant in a 1:2 hydromodule at a temperature of 30^0C for 12-24 hours. The prepared extract was separated from the solid phase in a centrifuge. Hot tap water was used to optimize the extraction process of biologically active substances and anthocyanins from fermented and sweet grapes of Saperavi and Cabernet Sauvignon grape varieties. Extractant-hydrochloric acid concentration was 0.1%, 0.5% and 1%. The initial moisture content (22-27%) and physical-chemical parameters of the seeds are given in Table 10.

Table 10. Moisture content and residual alcohol content

Indicator	Saperavi		Merlot		Cobern-Sauvignon	
	it is fermented	sweet	it is fermented	sweet	it is fermented	sweet
Humidity, %	26	23	23	27	22	23
Alcohol, h %	3.5	0.35	3.3	0.43	3.83	0.41
Carbohydrates, %	0	10.4	0	10.2	0	9.8

The study of the extraction process of wet and dry seeds showed that the use of water as an extractant does not make it possible to extract all biologically active substances. It has been determined that hydrochloric acid solutions are preferred for the extraction process. 0.5% hydrochloric acid is enough to remove the extractives. Obtained extracts have wine, malic, succinic acids, anions, potassium, magnesium, calcium, cations.

The extract obtained using 1% hydrochloric acid solution had significant amounts of sulfates and calcium cations. However, this should be taken as a negative. Because their high concentration causes the formation of sediment. In our observations, biopolymers, peptides, polysaccharides were recorded in the extract. They were released from the cell structure due to hydrolysis in an acidic environment and significantly weakened the filterability of the extract.

The excess amount of free hydrochloric acid was separated from the extract by rotary spinning in air flow. A higher amount of biologically active substances was observed in the fermented cells.

The anthocyanins present in grape seed extracts are of particular interest in terms of industrial application. The main anthocyanins of the varieties we studied are malvidin-monoglycoside. It accounts for about 60% of total anthocyanins by quantity. In the extracts we received, anthocyanins were 18-27% according to the identified substances, and 2-10% according to the total dry substances.

The study of rations containing bioactivated plant protein products, first of all the sprouted seeds of leguminous plants, has become relevant. Thus, during the germination process of the seeds of the mentioned plants, they are enriched with functional ingredients important for life.

The research has studied the possibilities of using the dispersed mass of germinated mung bean seeds without the shell. Commonly known methods of plant research were used to determine the physico-chemical characteristics of sprouted and crushed beans.

During the study, the total chemical composition, moisture content of the crushed mass, titratable acidity, and autolytic activity were determined.

The studies have shown that the chemical composition of the peeled, sprouted, and shredded mass can be characterized as follows: moisture content - 48.2-54.6%, high starch content - 44.0-45.6%, mono- and disaccharides - 3.5-4.8%, protein - 20-25%, fat - 2-3%, acidity - 3-4 degrees.

In sprouted mung bean samples, toxic elements exceeded the safety level of release, while microtoxins were absent, and pesticides were below the norm.

The analyses showed that peeled and crushed mung bean has the same autolytic activity (44.5-45.0%) as wheat of the first type, demonstrating its suitability for use in food. These values agree with the results obtained by Belarusian scientists. Bioactivated natural bean seeds had high autolytic activity when dispersed.

Thus, the results of our research raise the possibility of obtaining biologically active substances for functional food products from the bioactivated form of sprouting leguminous plant seeds. Germinated and dispersed mung bean seeds have high technological properties for application in functional beverages and other food products.

The fifth chapter is entitled "Investigation of improvement resources of functional beverage technologies." In this chapter, the study focuses on the use of fruit and plant raw materials, specifically currant fruit, in the production of functional beverages. It also explores the application of certain forest berries in beverage production and investigates the biologically active components of extractants and grain distillates.

Currants are known for their high vitamin content, similar to many other juicy fruits. There are four main types of currants: small red currant, large red currant, black currant, and yellow currant. Red currants typically yield a full harvest four years after planting, while

black currants require four to five years. With proper care, currant bushes can have a lifespan of 12 to 15 years, and in some cases, up to 20 years. The first crop usually appears two or three years after planting.

Studies have shown that currants are rich in nutrients, particularly vitamins (as shown in Table 11).

Table 11. Some composition indicators and nutritional value of currant fruits (per 100 g of fruit)

Content indicators	Red currant	Black currant
Water, g	70 (83.95)	72 (81.96)
Calorie content, kcal	56	63
Energy kC	191.8	264
Protein, g	1.3	1.4
Fats, g	0.2	0.4
Carbohydrates, g	7.9	15.4
Sugars, g	7.9 (10.40)	14
Dietary fiber, g	3.5	4.3
Vitamin C, mg	80	181
Calcium, mg	33	55
Sodium, mg	1.4	2
Magnesium, mg	13	24
Phosphorus, mg	44	59
Potassium, mg	275	322
Zinc, mg	0.23	0.27
Iron, mg	1-2	1-5
Vitamin B_1, mg	0.04	0.05
Vitamin B_2, mg	0.05	0.05
B_3, mg	0.1	0.3
B_5, mg	0.064	0.398
Vitamin B_6, mg	0.7	0.66
Antioxidant level	2.100	2.240 Micromole TEAC

When examining the data, it is evident that black currants have a more abundant composition and higher energy value compared to red currants. While the caloric content of red currants is 56 kcal, black currants contain 63 kcal. In terms of energy value, black currants provide 72.2 kC more energy than red currants. Protein, fats,

carbohydrates, sugars, vitamins, mineral elements, and other components significantly differ between black currants and red currants in terms of quantity. These variations were taken into account in subsequent studies.

Table 12 presents the main compositional indicators of black currants cultivated in different regions. It is evident that the composition of raw materials varies depending on the region of cultivation. As the altitude increases, the amount of biologically active substances, including ascorbic acid, folic acid, and other vitamins, also increases in the raw materials. Another notable factor is the increase in the quantity of dry matter and sugars in the product as it descends to the lowlands.

Table 12. Some compositional indicators of black currant cultivated in different regions, (per 100 g product)

Content indicators	Name of regions depending on zoning		
	Samukh	Ganja	Goygol
Water, g	83.6	84.1	82.3
Proteins, g	1.1	1.1	1.2
Fats, g	0.3	0.2	0.2
Carbohydrates, g	15.2	14.4	10.4
Mono and disugar, g	13.1	12.5	9.1
Cellulose, g	2.5	2.6	3
Starch, g	0.9	1.2	1.7
Pectin, g	0.45	0.42	0.96
Organic acids, g	2.3	2.6	3.5
Ash, g	0.95	0.91	0.87
β-carotene, mg	0.09	0.09	0.10
Vitamin E (tocopherol), mg	0.71	0.72	0.72
B_1 (thiamine)	0.04	0.03	0.05
B_2 (riboflavin), mg	0.03	0.04	0.04
Vitamin B_6, mg	0.10	0.11	0.13
B_9 (folic acid), mg	4.8	5	5.3
PP vitamin (niacin) mg	0.30	0.32	0.35
Vitamin C, mg	122	146	167

Studies have been conducted to determine the main bioflavonoids in currant berries. The results of that study are reflected in the table below (Table 13).

Table 13. Amount of some bioflavonoids in black currant

Amount of bioflavanoids, mg%	Regions		
	Samukh	Ganja	Goygol
Bioflavanoids	104	225	344
Flavanols	9.6	14.5	26.8
Oxycinnamic acid	25	37	51
Flavanols: free catechins	13.5	32.4	64.5
Proanthocyanidins	9.2	14.6	23.5

The anthocyanin content of blackcurrants is a topic of particular interest. Research indicates that nearly all black currant varieties, regardless of the specific variety or cultivation conditions, exhibit consistent levels of anthocyanin components (as shown in Table 14).

Table 14. Composition and amount of anthocyanins in blackcurrant fruits

Anthocyanins, mol/%	Regions		
	Samukh	Ganja	Goygol
Delphinidin-3-glucoside	18.6	15.4	7,8
Delphinidin-3-rutinoside	46.8	32,25	25,36
Cyanidin-3-glucoside	7,8	4.5	3.5
Cyanidin-3-rutinosite	32.4	38.3	44.5

Among the four anthocyanins identified in blackcurrants, Delphinidin-3-rutinoside (25.36-46.8 mol/%) and Cyanidin-3-rutinoside (32.4-44.5 mol./%) due to their higher concentrations.

Blackcurrants exhibit variations in the levels of several mineral elements in their composition. They contain varying amounts of iron, potassium, molybdenum, copper, and manganese. These elements play important roles in various biological processes.

The mineral content of blackcurrant berries cultivated in different regions is presented in the table below (Table 15).

Magnesium, known as a cofactor for numerous enzymes, is involved in protein and nucleic acid synthesis, as well as membrane stabilization. Iron is a constituent of proteins, including enzymes with diverse functions. It participates in electron and oxygen transport, facilitates oxidation-reduction reactions, and activates peroxide oxidation. Molybdenum acts as a cofactor for many enzymes and is

involved in the metabolism of sulfur-containing amino acids, purines, and pyrimidines.

Table 15. The amount of minerals in blackcurrant fruits

Amount of elements, mg/%	Regions		
	Samukh	Ganja	Goygol
Calcium	36.4	36.1	36.3
Phosphorus	34.2	33.7	34.5
Magnesium	32.4	32.3	31.9
Potassium	360	354	361
Sodium	34.1	34.3	34.1
Iron	1350	1380	1360
Zinc	146	140	142
Copper	135	137	138
Manganese	182	184	189
Iodine	1.1	1.0	1.3
Molybdenum	22	21.6	24.5

The information provided indicates that blackcurrants can be utilized in the production of functional beverages that are rich in biologically active compounds with potent antioxidant activity.

In the experiment, water-alcohol extracts from gooseberry, cranberry, and raspberry seeds were analyzed, and the following quality indicators were determined: dry matter (%) - 5.5; 6.2; 6.7, titratable acidity (%) - 0.56; 0.62; 0.58, vitamin C (mg/dm^3) - 89.71; 142.6; 408.8, dyes (mg/dm^3) - 4200.7; 6390.3; 4666.1, and phenol compounds (mg/dm^3) - 6010.8; 4914.3; 5320.7. The extracts exhibited high concentrations of dyes and phenolic compounds, indicating their potential use as biologically active substances in the production of non-alcoholic beverages.

These extracts were then employed in the development of functional beverages and recipe enhancements. The experimental samples of these beverages displayed unique organoleptic characteristics and demonstrated compliance with the quality standards.

Based on the research findings, it can be concluded that the extracts derived from the seeds of wild fruits and berries such as bramble, cranberry, and raspberry possess high levels of dye and phenolic compounds. Consequently, these extracts can be utilized to

enrich non-alcoholic and functional beverages with biologically active substances.

The sixth chapter is entitled "Development of Improved Beverage Technologies and Quality Indicators with Herbal Biologically Active Additives," focuses on various aspects related to the enhancement of non-alcoholic and alcoholic beverages, diet beverages, biomodified fermented milk beverages, and enriched yogurt technologies. The chapter also explores the application of improved and developed technologies, evaluates their economic efficiency, and examines their features.

The aim of the research was to develop the component composition of balanced beverages with medical-biological characteristics using the mathematical design method. In the first stage, the recipe was developed by determining the combination of powdered malt and polymalt extracts and evaluating their balance. The second stage involved the design of a functional soft beverage.

Several criteria were taken into consideration during the design process of the improved beverage. These criteria included balancing the composition in terms of nutritional value, macro- and microelements, and essential amino acids. The amount of specific ingredients such as vitamins, macro- and microelements was also taken into account to ensure functional properties, while considering medical-biological requirements and cost limitations.

In the following operations, we believe that the principle of superposition is fulfilled in terms of nutritional value, amino acids, macroelements, vitamin content and also other studied indicators during the combination of extracts.

As a balanced condition of the beverage, we use three important conditions that we determined based on reference data and expert opinion:

1. Balanced macronutrients of the beverage, ratio of protein to water carbon=1:4;

2. Being balanced on essential amino acids, tryptophan: lysine: methionine=1:3:3;

3. Balanced macroelements: calcium: magnesium: phosphorus=1:0.5:1.5.

Table 16. Amount of components in powdered malt and polymalt extracts

The amount of nutrients in product of 100 g, 1/100 g	In powdered malt and polymalt extracts			
	1*	2*	3*	4*
Proteins, C_P	10.25	13.08	11.73	25.65
Hydrocarbons, C_{HC}	80.0	72.5	79.1	54.4
Tryptophan, C_T	0.06	0.22	0.11	0.16
Lyzine, C_L	0.19	0.65	0.38	1.53
Methionine, C_M	0.21	0.59	0.27	0.27
Calcium, C_{Ca}	0.450	0.437	0.900	0.680
Magnesium, C_{Mg}	0.160	0.437	0.270	0.190
Phosphorus, C_P	0.120	0.262	0.250	0.070

1* - powdered polymalt: (barley, buckwheat, corn) extract; 2* - powdered polymalt: (barley, buckwheat, pea) extract; 3* - powdered buckwheat malt: extract; 4* - powdered pea malt: extract;

Table 17. Deviation of the amount of components in the extracts from the balancing ratio

Balancing ratio	Deviation from balancing ratio for powdered malt and polymalt extracts, β			
	1*	2*	3*	4*
C_P/C_{HC} = 1:4	-49%	-28%	-41%	89%
C_T/C_L = 1:3	-4%	3%	-12%	-68%
C_T/C_M = 1:3	-13%	13%	23%	80%
C_L/C_M = 1	-10%	10%	41%	467%
C_{Ca}/C_{Mg} = 2	41%	-50%	67%	79%
C_{Ca}/C_P = 2:3	460%	149%	437%	1350%
C_{Mg}/C_P = 1:3	304%	405%	227%	723%

A bias below 30% is found in extract 2*.

The balance of proteins, carbohydrates, tryptophan, lysine and methionine in 2* extract can be considered sufficient.

Blanching of calcium and magnesium is insufficient. The amount of phosphorus is lower than required. In 1* extract, essential amino acids (deviation does not exceed 13%) are well balanced, but imbalance of macronutrients and macroelements is also known.

The outliers in Table 17 are both positive and negative. Therefore, it is possible to achieve balance in any ratio when the

extracts with different sign bias are combined. Otherwise, it is achieved with the smallest total deviations for all ratios at the same time.

To achieve the balance of protein and water carbohydrates, it is necessary to combine powdered pea malt extract (positive bias δ=89%) with any extract such as 1*, 2*, 3* (they have negative biases -49%, -28%, 41%). To ensure the balance of essential amino acids, 2* extract with a positive bias (+3%) must be included in the extract combination (because other extracts have a negative bias. In addition, the presence of 1* extract is important for the balance of amino acids. This $\frac{C_T}{C_M}$ $\frac{C_L}{C_M}$ has negative trends (-13%, -10%) in terms of ratios. This is necessary to compensate for positive trends in other extracts. Using extract 2* ratio of macroelements in $\frac{C_{Ca}}{C_{Mg}}$ allows for a balance to be achieved, so that only this extract has a -17% bias among other positive extracts.

It should be noted that the amount of phosphorus in all studied extracts is much higher. Therefore, the ratios of $\frac{C_{Ca}}{C_P}$ and $\frac{C_{Mg}}{C_P}$ are significantly different (the difference is 1350%) for the purpose-valued extracts. The bias δ is then a positive quantity for all extracts and cannot be compensated for by combined extracts. Therefore, we exclude $\frac{C_{Ca}}{C_P}$ and $\frac{C_{Mg}}{C_P}$ ratios from further studies.

A generalized value of deviation from equilibrium δ for all different extracts is given in table 18.

Table 18. Generalized value of deviation from balancing for powdered malt and polymalt extracts

Extracts	Generalized cost of deviation from balancing, δ_{com}, %
1* - powdered polymalt: (barley, buckwheat, corn) extract	33
2* - powdered polymalt: (barley, buckwheat, pea) extract;	29
3* - powdered buckwheat malt: extract;	44
4* - powdered pea malt: extract;	124

The most balanced extract is extract 2* (its deviation from balancing is 29%). The least balanced extracts are 1*(δ_{com}=33%), 3*(δ_{com}=44%), 4*(δ_{com}= 86%).

It can be expected that in combining two and three extracts it is possible to obtain a better balanced extract (δ_{com}=18%) than in extract 2*.

Given that the initial extracts are four extracts (1*, 2*, 3*, 4*), six binary combinations of them are possible: 1-(1*+2*); 2-(1*+3*); 3-(1*+4*); 4-(2*+3*); 5-(2*+4*); 6-(3*+4*).

In order to study the influence of the composition of binary compositions of powdered malt and polymalt extracts on medical-biological balancing, a computer program in Object Pascal language was used in the Borland Delphi Integral software environment. Research results show that the protein/water carbon ratio is far from the required (1/4) composition in all variable ranges. The tryptophan lysine/ratio, on the other hand, practically coincides with the given ratio (1/3) in all the varying ranges of composition. The tryptophan/methionine ratio is close to the given ratio (1/3) in the 2* concentration range (about 20-40%). The lysine/methionine ratio is close to (1.0) if given in the range of about 18-35% of the 2* concentration. The calcium/magnesium ratio is close to (2.0) if given in the range of about 18-30% of the 2* concentration.

Thus, the (1*+2*) binary composition is sufficiently balanced in the range of 20-30% of the compositions in terms of the amount of essential amino acids and trace elements, but not sufficiently balanced in terms of the amount of macronutrients.

According to the obtained results, it is not appropriate to prepare extract compositions (1*+3*), (1*+4*) and (3*+4*). Because in such a combination, the deviation from the ideal balance does not decrease, on the contrary, it increases.

Based on the research results, the following composition (table 19) can be recommended for binary extract compositions.

Table 19. The most balanced binary combinations of powdered malt and polymalt extracts

Combination of extracts	Balance of macronutrients	Balance of essential amino acids	Balance of macroelements	β_{com}, %
76%1*+24%2*	-	++	+	
47%2*+53%3*	-	-	++	
73%2*+27%4*	+	--	++	

Note: "plus" and "minus" signs indicate: (++)-good balance; (+)-acceptable balance; (-)-weak imbalance; (--)-strong imbalance.

Triple combinations of extracts may improve balancing compared to binary combinations. It is possible to build four combinations from four named extracts: 1-(1*+2*+3*); 2-(1*+2*+4*); 3-(1*+3*+4*).

In conclusion, the best extract combination was determined, which from the balance of the necessary ingredients: 69.8%1*+25.0%2*+5.2%3* provides the smallest possible deviation from the mean *(β_{com}=15.0 %). The optimal composition was obtained 76%1*+24%2* closer to the previously recommended one. However, it is possible to improve the balance of macronutrients by adding 5% of 3*.

Table 20. Consumption of raw materials for gluten-free kvass (for 100 liters of kvass)

Raw materials	Mass share of dry matter in raw material	Consumption of raw materials in kind, kg
Sugar	99.91	49.89
Powdered sugar, buckwheat malt extract	96.83	20.87
Medicinal melissa extract (Melissa officinalis), dm^3	-	0.105
Dry pure bread culture	90.15	0.004
Lyophilized biomass lactic acid bacteria strain Lactobacillus plantarum EP-A3	90.07	0.003

It is also possible to use bifidobacteria in the gluten-free, probiotic kvass recipe (table 21).

It should be noted that the inclusion of the medicinal ingredient - melissa (the extract has a calming effect) in the recipe has a biological effect. The presence of lactic acid bacteria and bifidobacteria determines the immuno-biological properties of the beverage.

Table 21. Consumption of raw materials for gluten-free probiotic kvass (per 100 dal of kvass)

Raw materials	Mass share of dry matter in raw material	Consumption of raw materials in kind, kg
Sugar	99.90	50.7
Powdered sugar, buckwheat malt extract	97.13	20.79
Medicinal melissa extract (Melissa officinalis), dm^3	-	0.105
Pure technical dry bread culture Bifidobacterium bifidum, dm^3	-	40.08

Based on research results, a kvass recipe was developed using powdered polymalt (barley, buckwheat, pea), powdered buckwheat malt extracts (table 22). Here, peppermint (Mentha piperia L.) has spasmolytic, soothing, choleretic, antiseptic, astringent, hypotensive properties.

Table 22. Consumption of raw materials for kvass with curative and preventive properties (per 100 dal of kvass)

Raw materials	Mass share of dry matter in raw material,%	Consumption of raw materials in kind,kg
Sugar	99.88	50.8
3*	97.0	16.89
2*	97.0	4.4
4*	97.0	5.5
4*+2*	97.0	15.5
Peppermint (Mentha piperita L) extract, dm^3	-	0.105
Pure technical dry bread culture, lactic acid bacteria Lactobacillus plantarium 8P-A3	-	40. 0

Kvass recipe and consumption of raw materials for reabilitative nutrition are given in table 23.

Thyme (Thymus serpyllum L.) has broncholytic properties, restores epithelialization of tissues, and heals wounds.

Table 23. Consumption of raw materials for kvass according to the rehabilitative nutrition ration (per 100 dal of kvass)

Raw materials	Mass share of dry matter in raw material,%	Consumption of raw materials in kind,kg
Sugar	99.95	50.3
3*	97.0	16.1
2*	97.0	2.2
1*	97.0	3.2
Thyme (Thymus, serpyllum L) extract, dm^3	-	0.105
Pure technical dry bread culture, lactic acid bacteria Lactobacillus plantarium 8P-A3	-	40.0

The production of kvass, which was developed using powdered malt and polymalt extracts, involved a technological line comprising several stages. These stages included the preparation of powdered malt and polymalt from freshly germinated malt, preparation of kvass juice based on powdered malt and polymalt, preparation of sugar syrup and kohl, yeast and lactic acid bacteria preparation of broth, fermentation of kvass juice, preparation of plant raw materials, kvass blend, and filling of the finished beverage into containers. The technological stages and regimes are provided in picture 6.

Eight consumer properties were used to evaluate the improvement of alcoholic beverages based on extract distillates from oak alternative raw materials (cherry, plum trees). They include the following ones:

- Taste: pleasant, consistent with the expected flavor typical of the beverage category;
- Aroma: pleasant, typical of the beverage category;
- Color: appealing, specific to the beverage category;

• Aftertaste: pleasant, consistent with the expected flavor typical of the beverage category;

• Price range

• Price/quality ratio

• Naturalness (naturality) - absence of raw (material) ingredients of plant origin

• Alcohol safety.

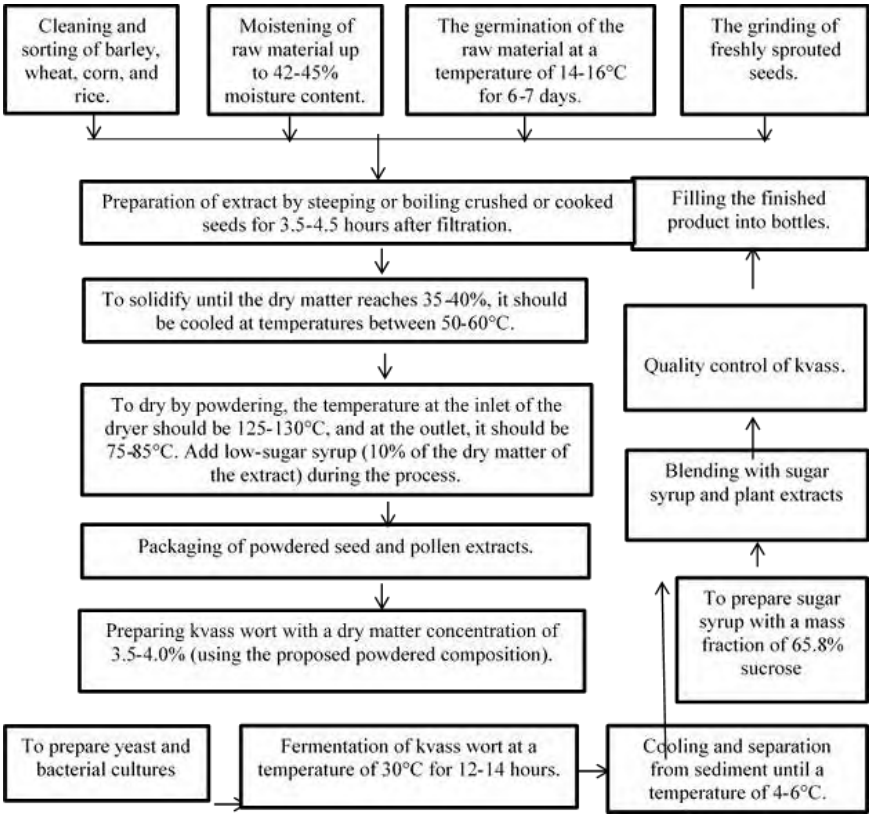


Figure 6. Technological scheme of kvass production using powdered malt and polymalt

In designing process of beverage, the physico-chemical and organoleptic characteristics of 13 alcoholic beverages represented on the market and beverages processed on the basis of the oak, cherry, and plum extracts (without blending) have been utilized (Table 24).

Each of the extracts approaches its market counterpart with a distinct set of characteristics. A blend of cherry, plum, and oak extracts was prepared, retaining their original organoleptic properties. This blend encompasses the main characteristics of various trees, such as fullness, softness of taste, and pleasant fruit shades. The proportions of the different types of tree extracts has been varied accordingly.

Table 24. Physico-chemical characteristics and organoleptic evaluations of extracts obtained from oak, cherry, and plum trees

Samples	Aromatic aldehydes, mg/dm^3	Inoculants, mg/dm^3	Blood acid, mg/dm^3	Water carbohydrates,	Furfural, mg/dm^3	Higher alcohols, mg/dm^3	Esters, mq/dm^3	Aldehydes, mg/dm^3	Organoleptic value, mg/dm^3
Oak	31.6	3.10	0.42	0.42	16.7	1984	136.3	12.3	8.95
Cherry	22.8	2.53	0.24	0.39	12.6	1962	127.2	13.9	10.0
Plum	28.3	2.4	0.34	0.29	13.4	1971	114.1	16.9	7.25

In the development of enhanced beverages, the concentration of components was determined based on the following factors: consumer demand for beverage quality, the anticipated organoleptic value of the beverage, and the projected psychological selling price of the product."

The analysis of the more clearly expressed correlations between the evaluation parameters allows us to come to the following conclusions. In order to enhance the organoleptic value of the beverage and increase its selling price, the amount of aromatic aldehydes (r=0.70) and inoculants (r=0.57) should be increased. Therefore, the amounts of aromatic aldehydes, inoculants and solid acids are increased simultaneously in market analogs. Beverages

prepared on the basis of cherry, plum and oak extracts contain more inoculants and blood acid than other analyzed market analogs. In this regard, considering the combination of the proposed extracts, it can be expected to obtain a beverage with both a high organoleptic value and a high psychological selling price.

The amount of higher alcohols (r=-0.48, r=-0.27) has a negative effect on the organoleptic value and selling price of the beverage. Moreover, with the increase in the amount of higher alcohols, the amount of aromatic aldehydes decreases (r=-0.71). Their presence can contribute to the enhancement of both the organoleptic quality and selling price of the beverage. In addition, with the increase in the amount of higher alcohols, the amount of esters also increases (r=0.53). This leads to an increase in the psychological selling price of the beverage (r=0.15). According to the amount of higher alcohols, aromatic aldehydes and esters, the beverages we have developed on the basis of extracts from oak, cherry and plum trees, compared to market analogs, demonstrate an advantage of having a large amount of water carbohydrates and a small amount of aldehydes. This leads to an increase in the psychological selling price of the beverage (correlation coefficient of 0.12 and 0.20), as well as an enhancement in the organoleptic value (correlation coefficient of 0.39 and 0.05)

An increase in the amount of plum tree extract in combination with oak tree extract leads to an increase in both the organoleptic value and selling price of the beverage. Therefore, the addition of plum tree extract to any amount of oak tree extract can improve the quality and selling price of the beverage. In this case, it is possible to achieve high indicators if the concentration of plum wood is 85%: the consumption quality exceeds 0.9, the organoleptic value surpasses 9.8 points, the psychological selling price is 11.5 AZN/dm^3.

The optimal composition of the combination of extracts is as follows: 0-7% for oak tree extract, 0.25% for cherry tree extract, 70-100% for plum tree extract. In this case, the production quality of the beverage is more than 0.9, the organoleptic value is -9.25, and the psychological selling price is 11.5 AZN/dm^3.

The study of improved alcoholic beverage technologies with supplement of plant origin, considering the indicators of quality and

the selling price, alcoholic beverage coupages (blends) obtained by distillation from grain raw materials have determined the following optimal ingredient ratios: 5%-oak tree extract; 25% cherry tree extract; 70% plum tree extract.

The main financial and economic indicators demonstrate the economic efficiency of applying the developed technologies at the industrial production level.

The annual net income from the sales of alcoholic beverages amounts to 12.181×10^6 AZN. In this case, the profitability of production reaches 28.8%, which is considered high. The payback period of the investment in the production of alcoholic beverages is 3.6 years.

The revenue from non-alcoholic beverages amounts to 8.569×10^6 AZN, with net income of 2.805×10^6 AZN. The profitability of non-alcoholic beverage production equals to 18.1%. The payback period of the investment in this direction is 5.7 years.

Therefore, the calculated economic efficiency of the implementation of the developed and proposed technical issues in the production of distilled alcoholic beverages is as follows: revenue of 17,687 AZN "per thousand liters of distilled alcoholic beverages", revenue of 3,065 AZN per ton of dry beverage concentrate, revenue of 1,329 AZN per thousand dal of kvass, and revenue of 1,184 AZN per ton of powdered malt and polymalt.

Results

1. The selection of biosources with the required enzymatic complex and biologically active components, such as bioflavonoids, vitamins, macro- and microelements, hydrocarbons, amino acids, and gluten fractions, is scientifically justified. Their significant potential in the development of intensive technologies for alcoholic and non-alcoholic functional beverages has been identified.

2. The rational and optimal parameters for the extraction process of oak, cherry, and plum wood shavings are as follows: a raw material-extractant ratio of 30 g/100 cm^3 and volume shares of ethanol in the extractant of 50%, 30%, and 40% for the respective wood samples. A method of combined processing of wood shavings has been

developed. The optimal parameters for ultrasonic extraction include a frequency of 30 kHz, a duration of 15 minutes every hour, and a total extraction time of 15 days.

3. The technological regimes for the preparation of buckwheat malt have been optimized, including a temperature of 15.6°C, a germination period of 6.0 days, and a humidity of 44.0%. Rational methods for obtaining malt and polymalt extracts have been developed. The spray drying parameters for powdered malt and polymalt extracts have been optimized with an inlet temperature of 125-130°C and an outlet temperature of 75-85°C.

4. The germination process of grain raw materials has been optimized for the production of barley and wheat malts. The germination periods were 6.1 and 5.8 days, with humidities of 44.1% and 45.2%, and temperatures of 17.6°C and 15.9°C, respectively. A modified crushing mode has been developed for barley, rye malt, and corn grain composition. The process of biological acidification of juice using L. Plantarum 8P-A3 for the production of yeast has been studied. Fermentation time using Sacch. Cerevisiae Fermiol (DY7221) at 30°C has been reduced to 64-66 hours.

5. The functional properties of herbal extracts were evaluated. Ginseng, fresh-shaped malt, and polymalt contain vitamin "B_1" at levels of 57.3-88.7, calcium at levels of 54.6-112.5, and magnesium at levels of 53.3-145.7 as a percentage of the recommended consumption. The amount of bioflavonoids is on average twice the recommended daily consumption. The powdered buckwheat extract contains 20.4 mg/100 g of gluten. Therefore, powdered buckwheat malt can be used as a standalone product or as an ingredient in gluten-free product recipes.

6. The proportion of tree extracts for alcoholic beverages was calculated based on the combination of extracts: oak tree extract - up to 7%, cherry tree extract - up to 27%, and plum tree extract - 70-100%.

7. Functional alcohol-free, balanced beverages with macro-nutrients, essential amino acids, and macroelements were formulated using powdered malt and polymalt extracts. The composition includes 69.8% powdered polymalt (barley, buckwheat, corn) extract, 25%

powdered polymalt (barley, buckwheat, pea) extract, and 5.2% powdered buckwheat extract.

8. It was determined that the composition of the beverage designed for therapeutic preventive nutrition should include 20% powdered buckwheat malt extract. For the rehabilitation feeding group, the ingredient composition should include 15% powdered polymalt (barley, buckwheat, corn) extract, 10% powdered polymalt (barley, buckwheat, pea) extract, and 75% powdered buckwheat malt extract.

9. The main financial and economic indicators demonstrate the economic feasibility of implementing the developed and improved technologies for alcoholic and non-alcoholic beverages at an industrial level. The estimated economic impact of addressing the technical issues is 17,687 thousand AZN for 1000 branches of alcoholic beverages, 3 thousand AZN for 1 ton of dry beverage concentrate, and 1,184 thousand AZN for 1 ton of powdered malt and polymalt.

Recommendations for production

In the production of alcoholic and non-alcoholic beverages, it is recommended to select locally available examples of biologically active substances of plant origin. This should be done to satisfy consumer interests in terms of quality, modern healthy nutrition, diet, therapeutic-prophylactic and rehabilitative nutrition, as well as functionality. Furthermore, it is advisable to choose justified types of sprouts from cereal and leguminous plants, including barley, buckwheat, corn, pea, horse bean, and mung bean. The application of powdered variants of extracts obtained from these sprouts, along with the utilization of the technological schemes and regimes presented in the dissertation for the production of beverage concentrates based on powdered malt and polymalt, is recommended.

The ingredients for powdered beverage recipes should include powdered malt and polymalt extracts in the ratios indicated in the research results. Additionally, natural flavorings, natural dyes, food acids, soluble starch, dry whey, and lyophilized cultures of lacto- and bifidobacteria in powdered dry herbal extracts should be used. It is important to ensure that the concentration of the biologically active

components in the formulation preserves the functional effect of the active ingredients and falls within the normative values.

The main provisions of the dissertation are reflected in the following published articles:

1. Gurbanov, N.H, Gadimova, N.S, Yusifzade, Sh.H. The use of hazelnut kernel powder in the production of combined fermented milk products // 80th International Scientific Conference of Young Scientists, Graduates and Students, Kyiv-2014. 48-49.
2. Azimov, A.M., Akhundova, N.A., Gadimova, N.S. Technology of milk and milk products. Textbook. "Economics University" Publishing House, Baku, 2016, p.382.
3. Abbasbeyli, G.A, Gadimova, N.S, Akhundova, N.A. Biotechnology. Textbook. "İqtisad University" Publishing House, Baku, 2016, p.338. https://library.unec.edu.az/images/Abbasb%C9%99yli%20v%C9%99%20b.%20Biotexnologiya.pdf
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