Development of beer drinks recipe and technology with fruit and berry raw materials

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Abstract. This study aimed to develop recipes and technology for beer drinks based on fruit and berry raw materials to broaden the variety of domestic drinks and achieve high-quality, safe products with good flavor characteristics. Beer drinks were the objects of the study. The main ingredients for the beer drink were unfiltered light beer "Prazhskoye" from a private brewery in Kemerovo, as well as cherry, raspberry, and blackcurrant juice. The study used generally accepted methods of analysis of organoleptic, physicochemical, and microbiological quality indicators. Recipes and technology of beer drinks were developed. The dosages of cherry, raspberry, and currant juices were determined during the study of the influence of the introduced juices, the complex estimation of qualitative indicators of beer drinks was performed, and the shelf life was determined. The obtained results enable the company to expand its beer product line and meet customer demand for high-quality domestic beverages made from fruit and berries.

1 Introduction

Beer is the most popular alcoholic beverage in the world and one of the oldest fermented beverages, dating back over eight thousand years. Since ancient times, many different types of beer and beer-based drinks have been developed in different countries around the world. The great diversity of raw materials and technologies used in their production ensure the variety of these drinks.

According to the Reinheitsgebot (the beer purity law regulating commercial brewing in Germany, first introduced in Bavaria in 1516), beer could only be brewed from water, barley malt, hops, and yeast. However, in other countries, the laws governing beer production are less strict, and brewers have more flexibility in choosing carbohydrate sources (additives). Brewing additives are a source of carbohydrates other than barley malt, which contributes sugar to the wort. The most widely used are cereals (malted or unmalted), sugar syrups, usually combined with barley malt, protein concentrates of nut oil by-products, and collagen raw materials [1-2]. In addition, new health-oriented lifestyle trends and changing consumer preferences have outlined the trend of developing a range of beer drinks using new raw fruit and berry materials [3-4]. Because there is no natural yeast in the grain, the wort is fermented using fruit, wine, or honey. The diverse range of plant

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raw materials available for use in the production of beer and beer-based products allows producers to conquer new markets and meet the needs of individual consumers.

The use of plant raw materials is justified by their biological value, ability to add nutritional value to the product, and health benefits. Antioxidants play an important role in brewing because of their ability to delay and prevent oxidation reactions. The antioxidant capacity of beer and beer drinks mainly depends on the content of phenols and Maillard compounds. Polyphenols in beer and beer drinks come from barley (malt) (70–80%) and hops (20–30%), which are the main raw materials for their production. However, aside from the effect of raw materials, the total antioxidant content of beer and beer beverages is heavily influenced by the brewing process [5]. Phenolic compounds, particularly flavonoids and stilbenes, have a variety of bioactive properties, including anti-inflammatory, antimicrobial, anti-allergic, antithrombotic, anticarcinogenic, antimutagenic, and vasodilating properties. A study of commercial fruit beer varieties on the consumer market for bioactive compounds, polyphenolic profile, amino acid profile, and antioxidant activity conducted by researchers at the Czech University of Natural Sciences and the CREA Research Center Food and Nutrition in Italy showed that the addition of fruits and berries (cherry, raspberry, peach, apricot, grape, plum, and apple) increased the antioxidant activity of beer and qualitatively and quantitatively improved its phenolic profile. An increase in catechin and quercetin content was observed in all fruit beers studied [6-7].

In addition to their physiological role, phenols have a significant influence on the organoleptic properties of beer and beer drinks, forming taste, mouthfeel, aroma, astringency, and bitterness [6]. Increasing antioxidant content from natural sources to improve flavor stability and shelf life of beer drinks a growing trend in the food industry [8].

In recent years, the market for specialty beer drink varieties with improved health benefits and/or new refreshing flavors has grown significantly. The range of berry- and fruit-based beer drinks is expanding. The use of raspberries, blueberries, and strawberries as food sources and natural ingredients rich in antioxidants for disease prevention has emerged as a major objective in modern food and health research [9-10]. Extraction of target components of fruit and berry raw materials for further use in special-purpose beer technologies has been studied [11].

The tendency to replace expensive brewing malt with unburnt carbohydrate-containing raw materials and the search for alternative flavor additives is one of the most important and urgent tasks of the beer drink industry. Considering the technological peculiarities of beer drink production, the main process of which is fermentation, resulting in the formation of flavor and aromatic characteristics of the finished product, the optimal composition of the medium for fermentation with beer yeast is of great importance.

The use of various plant and animal raw materials in beer drink technology allows for the production of drinks with specific quality indicators that meet the needs of different population groups [12].

The development of special types using fruit and berry plant raw materials to form new physical, chemical, organoleptic, and physiological properties of drinks is the modern vector for expanding the range of beer drinks [11]. New types of beer drinks can be developed using available sources of carbohydrates as additives, in particular, honey, fruit and berry raw materials and their products, juices, milk whey, such non-traditional additives as collagen, vegetables, herbs, and other components, as well as their combinations.

However, a number of theoretical and practical issues in the development of new technological challenges remain unresolved. When developing technologies for beer and low-alcohol beer drinks, special consideration should be given to technological modes that

make the best use of traditional brewing processes, existing technological equipment, production experience, and traditions.

The foregoing provided the aim of the study.

The study aimed to develop the recipe and technology for beer drinks with the use of fruit and berry raw materials and to form their qualitative characteristics.

To reach the aim, the following objectives were addressed: determining the dosage of juices (cherry, currant, raspberry) in the recipe of a beer drink based on light unfiltered beer "Prazhskoye" by studying the standardized quality indicators and identifying the best sample by aggregate characteristics.

2 Materials and methods

The objects of research were model samples of beer drinks made from light unfiltered beer: with cherry juice, currant juice, and raspberry juice.

The light unfiltered beer "Prazhskoye" was used as the base for the drinks, and juice from cherries, currants, and raspberries was added to the beer wort in amounts of 10, 20, and 30%.

Clarified cherry, currant, and raspberry juices produced in compliance with GOST 32102-2013 Group H54 "Canned foods. Juice products. Concentrated fruit juices. General specifications" were used to prepare the samples.

Beer drinks were sampled according to GOST 12786 "Brewing products. Acceptance rules and methods of sampling". Quality indicators of beer drinks samples were determined according to the requirements of GOST 55292-2012 "Beer drinks. General specifications".

Organoleptic parameters: appearance, taste and aroma, color, as well as foam height and head retention were determined according to GOST 30060-2022 "Brewing products. Methods for determination of organoleptic indices and product's volume".

The volume fraction of ethyl alcohol was determined according to GOST 55292-2012 and GOST 12787 "Brewing products. Methods for determining the volume fraction of ethyl alcohol, the mass fraction of the actual extract and calculation of the initial wort extract".

The mass fraction of carbon dioxide was analyzed according to GOST R 51154-98 "Beer and beer drinks. Methods of determination of carbon dioxide and stability".

In addition, the indicators not covered by GOST 55292-2012 requirements – hydrogen index and color – were investigated. The hydrogen index was calculated using GOST 31764-2012 "Beer. Method of determination of pH" given that the hydrogen index (pH) of beer drinks ranges from 3.8 to 4.8.

Color was determined according to GOST 12789 "Beer. Methods for determination of color", considering that the color of beer drinks is within the range from 0.2 to 2.5 color units or within the range from 3.4 to 31 EBC units.

3 Results and Discussion

The beer drinks were prepared based on the recipe for light unfiltered beer "Prazhskoye" brewed in the conditions of a private brewery of small and medium-sized production LLC "Sigma", Kemerovo, Russia. The recipe for light unfiltered beer "Prazhskoye" is presented in Table 1.

The beer was brewed under industrial conditions in a hermetically sealed tank and aged for 21-22 days after brewing. The beer's density was 12%.

Model samples of beer drinks were prepared by adding juices (cherry, currant, raspberry) in amounts of 10, 20, and 30% of beer wort, which corresponds to the requirements for the preparation of beer drinks, which require at least 40% beer wort.

Table 1. Recipe for making light unfiltered beer "Prazhskoye" (consumption per 600 liters of the finished beer).

Raw materials	Quantity, kg
Pilsen barley malt	125
Perle bitter hop pellets 10.0%	0.340
Zatecky aromatic hop pellets 3.0%	0.490
Saflager dry yeast 34\70	0.028
Enzyme preparation (clarifier)	0.030

After adding the juices, the beer drinks were stirred for 10 minutes with a built-in frame stirrer at a speed of 60-100 rpm, then cooled to 4±2 °C to determine the organoleptic and physicochemical quality parameters.

The physico-chemical parameters of the samples of drinks based on the light unfiltered beer "Prazhskoye" with cherry juice are presented in Table 2.

Table 2. Physico-chemical properties of beer drinks based on "Prazhskoye" beer with cherry juice addition.

	Quantity of cherry juice, %			GOST R
Indicator	**10**	**20**	**30**	**55292- 2012**
Volume fraction of ethyl alcohol, %, max.	4.3± 0.2	4.1± 0.2	3.9± 0.2	7.0
Mass fraction of carbon dioxide, %, min.	0.5± 0.08	0.5± 0.08	0.4± 0.05	0.4
Fobbing				
foam height, mm, minimum	28	26	19	20
foam retention, minutes, minimum	1.9	1.6	0.4	1
Color, color units	0.4	0.7	1.6	0.2-2.5
pH	3.9	4.1	4.3	3.8-4.8
Titratable acidity, cm^3	2.2± 0.1	1.3± 0.1	1.1± 0.1	1.2-2.6

Analyzing the obtained data on the cumulative evaluation of organoleptic and physicochemical quality indicators, it was discovered that the sample of the drink containing 20% cherry juice had the best properties. The drink with 20% cherry juice added had a pleasant light cherry aroma and a mild pleasant sweet-sour taste, with an almond aftertaste and hop bitterness. The color was a rich, deep red.

According to physicochemical parameters, the drink with 20% cherry juice also met the standardized requirements.

The physico-chemical quality parameters of samples of beer drinks with currant juice are presented in Table 3.

Table 3. Physico-chemical properties of beer drinks based on "Prazhskoye" beer with current juice addition.

	Quantity of cherry juice, %			GOST R
Indicator	**10**	**20**	**30**	**55292- 2012**
Volume fraction of ethyl alcohol, %, max.	4.5± 0.2	4.0± 0.2	3.8± 0.2	7
Mass fraction of carbon dioxide, %, min.	0.5± 0.08	0.4± 0.05	0.2± 0.04	0.4
Fobbing				
foam height, mm, minimum	22	16	18	20
foam retention, minutes, minimum	1.4	1.0	0.4	1
Color, color units	0.7	1.3	1.6	0.2-2.5
pH	4.1	4.3	4.6	3.8-4.8
Titratable acidity, cm^3	1.3	1.1	1.0	1.2-2.6

Analyzing the obtained data on the cumulative evaluation of organoleptic and physicochemical quality indicators, it was discovered that the sample of the drink with 10% currant juice possessed the best properties. The drink with 10% juice added had a pleasant light berry aroma and mild pleasant sour-sweet taste, as well as a refreshing aftertaste and hop bitterness. The color was a brownish red. The drink's foam was thick and pinkish in color.

According to physico-chemical parameters, the drink with 10% currant juice also met the standardized requirements. Higher juice dosages decreased foam retention and foam height.

The physico-chemical quality parameters of the samples of drinks with raspberry juice are presented in Table 4.

Table 4. Physico-chemical properties of beer drinks based on "Prazhskoye" beer with raspberry juice addition.

	Quantity of cherry juice, %			GOST R 55292- 2012
Indicator	**10**	**20**	**30**	
Volume fraction of ethyl alcohol, %, max.	4.5	4.1	3.9	7
Mass fraction of carbon dioxide, %, min.	0.5± 0.08	0.46± 0.08	0.44± 0.08	0.4
Fobbing				
foam height, mm, minimum	22	24	25	20
foam retention, minutes, minimum	1.2	1.4	1.5	1
Color, color units	1.3	1.1	0.7	0.2-2.5
pH	3.9	4.0	4.2	3.8-4.8
Titratable acidity, cm^3	2.1	1.9	1.4	1.2-2.6

Based on the data analysis, it was discovered that the sample of beer drink with 30% raspberry juice has the best flavor characteristics and meets the standardized requirements in terms of physico-chemical parameters.

4 Conclusion

Beer drink recipes and technology based on fruit and berry raw materials (cherry, currant, and raspberry juice) were developed. The optimal dosages of juices were selected: cherry – 20%, currant – 10%, raspberry – 30%. The quality of the developed drinks was comprehensively assessed by organoleptic and physicochemical quality indicators. Practical implementation of the proposed technological solutions will allow the enterprise to expand the range of marketable products and satisfy the demand for quality drinks based on natural fruit and berry raw materials.

References

1. I.V. Novikova, L.V. Antipova, T.I. Romanyuk, O.A. Bovva, M.S. Kudryashov, Bulletin of the Voronezh University of Engineering Technologies. **82**, 50-57 (2020)
2. D. Sen, D. Kahveci, Waste and Biomass Valorization. **11**, 5099-5107 (2020)
3. Yu.I. Kretova, I.V. Kalinina, Bulletin of the South Ural State University. Series: Food and biotechnology. **10**, 5-14 (2022)
4. L. C. Salanță, T. E. Coldea, M. V. Ignat, C. R. Pop, M. Tofană, E. Mudura, Zhao, H. Processes. **8**, 1613 (2020)

5. Zh. Baygazieva, G.I. Baygazieva, A.K. Kekilbayeva, Series chemistry and technology **2,** 128-134 (2021)
6. D. K. Baigts-Allende, A. Pérez-Alva, M. A. Ramírez-Rodrigues, A. Palacios, M. M. Ramírez-Rodrigues, Journal of Food Composition and Analysis **100**, 103921 (2021)
7. M. Nardini, I. Garaguso, Food chemistry. **305**, 125437 (2020)
8. K. Habschied, A. Živković, V. Krstanović, K. Mastanjević, Beverages **6,** 51 (2020)
9. B. Baby, P. Antony, R. Vijayan, In Crit Rev Food Sci Nutr. **58**, 2491-2507 (2018)
10. J. Kawa-Rygielska, K. Adamenko, A. Z. Kucharska, P. Prorok, N. Food Chemistry **281**, 147-153 (2019)
11. A.K. Kekibayeva, A.A. Kantay, G.I. Baygaziyeva, The Journal of Almaty Technological University. **3,** 79-84 (2020)
12. Liana Claudia S., Teodora Coldea, Maria Valentina Ignat, Maria Tofana, Processes **8,** 1382 (2020)