МРНТИ 65.43.31 https://doi.org/10.48184/2304-568X-2023-1-12-18

USING OF NONTRADITIONAL RAW MATERIALS IN BEER PRODUCTION

*[1]A.A. KERIMBAYEV** , *[1]A.A AKHMETZHANOV* , *[1]A.I. IZTAYEV* ,
[1]G.I. BAIGAZIYEVA , *[1]A.A. KEKIBAEV*

([1] Almaty technological university, Kazakhstan, 050012, Almaty, Tole bi str., 100)
Corresponding auther e-mail: a.kerimbayeva@gmail.com*

Given the highly competitive environment of brewing industry today, businesses need to constantly develop new products of high quality and nutritional value that meet consumer and sanitary requirements. Therefore, the production of beer-based mixed beverages using nontraditional raw plant materials is gaining popularity. It is quite possible to produce these types of beverages at brewing facilities of Almaty and the Almaty region since it presents a favorable climate to develop agricultural businesses producing fruits and berries and has a large potential for using wild crops. Using of these plants will keep the enterprise economically viable by expanding the assortment of products and increasing the share of low-alcohol beverages in total production. In this study, the purpose is to select the optimum method for the production of special beer based on apple and grape juice. The choice of these particular types of raw plant materials was due to their wide availability and suitability for juice processing. The methods of introducing juice into young beer after the post-fermentation stage, as well as the introduction of fermented juice into young beer, were applied in the production of a mixed beverage. The organoleptic, physicochemical properties of the finished beer made using two methods have been studied. As a result, the optimal beer to juice ratio of 70:30 was selected according to the first method. This method resulted in the most balanced combination in terms of organoleptic characteristics, but colloidal instability was observed. For the second method of special beer production, the Oettinger Pils yeast race was used for fermentation of the juice base that was introduced into young beer after the post-fermentation stage. The resulting beverage at the 50:50 ratio of beer to juice was highly stable and had the highest organoleptic and physicochemical qualities.

Keywords: special beer, beer mixes, fruit and berry juice, fermentation, production.

ПРИМЕНЕНИЕ НЕТРАДИЦИОННОГО СЫРЬЯ В ПРОИЗВОДСТВЕ ПИВА

[1]А.А. КЕРИМБАЕВА, [1]А.К. АХМЕТЖАНОВА, [1]А.И. ИЗТАЕВ*
[1]Г.И. БАЙГАЗИЕВА, [1]А.К. КЕКИБАЕВА

([1]Алматинский технологический университет, Казахстан, 050012, г.Алматы, Толе би 100)
Электронная почта автора корреспондента: a.kerimbayeva@gmail.com

С учетом высокой конкуренции и условий, в которых находится пивоварение, предприятиям необходимо постоянно заниматься разработкой новых продуктов, отвечающих потребительским, санитарным требованиям, высоким качеством и пищевой ценностью. А также переориентировать структуру потребления казахстанцами алкоголя в сторону менее крепких напитков, что является общемировой прогрессивной практикой. В связи с этим актуальным направлением является производство комбинированных напитков на основе пива с использованием нетрадиционного растительного сырья. Целью представленных исследований является проведение работы по подбору оптимального способа производства пива специального назначения на основе сока яблока и винограда. Выбор данного растительного сырья связан с широкой сырьевой базой и возможностью переработки в сок. При производстве смешанного напитка применяли способ введения готовых соков в молодое пиво после стадии дображивания, а также введение сброженных соков в молодое пиво. Исследованы органолептические и физико-химические показатели готового пива произведенного по двум способам. В результате по первому способу подобраны оптимальные соотношения пиво: сок, 70:30, где имеется наиболее гармоничное сочетание по органолептическим характеристикам, но по данному способу наблюдается коллоидная нестабильность. При производстве пива специального по второму способу, применяли расу дрожжей Oettinger Pils для сбраживания соковых основ и вводили в молодое пиво после стадии дображивания. В результате при соотношении пиво: сок в концентрации 50:50 наблюдались наивысшие органолептические и физико-химические показатели качества, а также высокая стабильность напитка.

Ключевые слова: пиво специальное, бирмиксы, плодово-ягодные соки, сбраживание, производство.

СЫРА ӨНДІРІСІНЕ ДӘСТҮРЛІ ЕМЕС ШИКІЗАТТАРДЫ ҚОЛДАНУ

[1]А.А. КЕРИМБАЕВА, [1]А.К АХМЕТЖАНОВА, [1]А.И. ИЗТАЕВ,*
[1]Г.И. БАЙГАЗИЕВА, [1]А.К. КЕКИБАЕВА

([1]Алматы технологиялық университеті, Қазақстан, 050012, Алматы қ., Төле би к-сі, 100)
Автор-корреспонденттің электрондық поштасы: a.kerimbayeva@gmail.com*

Жоғары бәсекелестікпен сыра қайнату жағдайларын ескере отырып, кәсіпорындар үнемі тұтынушылық, санитарлық талаптарға, жоғары сапа мен тағамдық құндылыққа сәйкес келетін жаңа өнімдерді әзірлеумен айналысуы керек. Сондай-ақ қазақстандықтардың алкогольді тұтыну құрылымын күшті сусындарға қайта бағыттау, бұл жалпы әлемдік озық тәжірибе болып табылады. Осыған байланысты дәстүрлі емес өсімдік шикізатын қолдана отырып, сыра негізіндегі аралас сусындар өндірісі өзекті бағыт болып табылады. Ұсынылған зерттеулердің мақсаты алма және жүзім шырыны негізінде арнайы бағыттағы сыраны өндірудің оңтайлы әдісін таңдау бойынша жұмыстар жүргізілді. Бұл өсімдік шикізатын таңдау кең шикізат базасымен және шырынды өңдеу мүмкіндігімен байланысты. Аралас сусын өндірісінде ашыту кезеңінен кейін жас сыраға дайын шырындарды енгізу әдісі, сондай-ақ жас сыраға ашытылған шырындарды енгізу әдісі қолданылды. Екі әдіспен өндірілген дайын сыраның органолептикалық және физика-химиялық көрсеткіштері зерттелді. Нәтижесінде, бірінші әдіс бойынша сыраның оңтайлы қатынасы таңдалды:шырын, 70: 30, онда органолептикалық сипаттамалары бойынша ең үйлесімді комбинация бар, бірақ осы әдіс бойынша коллоидтық тұрақсыздық байқалады. Екінші әдіс бойынша арнайы сыра өндірісінде шырын негіздерін ашыту үшін Oettinger Pils ашытқы түрі қолданылды және ашыту сатысынан кейін жас сыраға енгізілді. Нәтижесінде сыра: шырын 50:50 концентрациясында сапаның ең жоғары органолептикалық және физика-химиялық көрсеткіштері, сондай-ақ сусынның жоғары тұрақтылығы байқалды.

Негізгі сөздер: арнайы сыра, бирмикстер, жеміс-жидек шырындары, ашыту, өндіріс.

Introduction

Nowadays the brewing industry of Kazakhstan is one of the dynamically developing markets of the raw materials industry of the republic. It is modern and innovative.

Currently, there is an increase in the production of low-alcohol and non-alcoholic beverages, which prompts manufacturers to increase their production volumes. Amongst the most popular in Europe are low-alcohol beverages such as Belgian "Lambic" and "Liefmans Kriek" and mixed beer-based beverages, such as English special beer "Lager and Lime", German beer cocktail "Radler", Dutch apple beer "Bavaria", fruit lambic, kriek, gueuze, faro, rouge [1,2]. According to the classification established, beer-based mixed beverages – beer mixes or special beers are beverages consisting of beer and any soft drink, such as soda or juice. Flavored beer is also classified as a beer mix [3,4,5].

The production of such beverages is still a very new segment of the beverage market and is increasingly popular amongst consumers. Therefore, the development of a special beer technology using various juices, which will contribute to the expansion of the range of mixed beverages is an urgent task [6].

In order to maintain their brands' position on the market, manufacturers strive for mastering new marketing and creative ways, including by adding special types of beer, such as beer mixes, into their assortment [7,8].

Beer mix is a newly developing market segment in many countries [9]; they correspond to the tendency to reduce the alcohol content in modern beverages, and the refreshing and flavor properties of beer are common knowledge. The emergence of a new innovative product causes a stir on Kazakhstan's market while opening a new niche.

Due to the purpose represented above, the study of the possibility of the application of fermented fruit bases in the production of special beer is the purpose of the presented research.

To achieve this goal following tasks have been defined. 1. To select possible ways of introducing ready fruit juices into the young beer during production. 2. Analyse the organoleptic and physicochemical quality parameters according to the developed production regimes of the ready beverages.

These results will expand the range of products produced by breweries and increase the demand for craft brewing.

Materials and Research Methods

To develop a special beer technology, the following materials were used: light barley malt as per the State Standard 29294-2014, granulated hops as per the State Standard 32912-2014 [19-20], the α-acid content of 3%, the moisture content of 8%, apple and grape juice concentrated according to the manufacturer's specifications. For producing grape juice, the red grape variety Cabernet Sauvignon was used, for producing apple juice – Aport. Apple and grape juices were prepared by adding an appropriate amount of water.

Production of special beer on the basis of semi-finished fruit and berry products was carried out in the educational and scientific center "Fermentation Products Manufacturing Technology" of the Almaty Technological University at the 50 L4 mini-brewery, which allows producing up to 50 liters of beer in each cylindrical conical tank.

Main quality indicators were determined in accordance with the State Standard 31711-2012 Beer, General specifications, as well as the methods given in the literature [21,22].

Literature review

Currently, the brewing industry is leading the way in the production of fermented beverages. To remain competitive in the market, breweries need to broaden their product range, develop functional beverages based on natural, plant-based raw materials and increase craft brewing to find new consumers. In this context, the breweries show a strong interest in beer mix producing. Without new investments to revamp the technological equipment, the production of beer mixes will allow for:

- increasing the production volumes by attracting new target groups of consumers;
- expanding the range of products;
- ensuring business growth.

Beer from different countries has its own flavor and aroma bouquet often created by non-traditional additives: ready-made soft drinks, fruits, as well as herbs and spices, which also make beer good for health [10,11].

At present, methods have been developed for producing beer mixes using wort granules and non-alcoholic flavored beverages. For example, vanilla or cinnamon, nutmeg, and ginger rich in essential oils, which give the beverage a memorable aroma and light refreshing taste are widely used in beer production [12].

Pine cone beers are widely known in Northern Europe and North America. The beer resembles a reddish brown porter with a thick head of foam and an obvious pine aroma that does not overpower the malt flavor. There is a so-called "red beer", which is obtained by adding extracts from various herbs and flowers [13].

One of the strong beers is made by adding glucose-fructose syrup, cognac or fruits, berries, and roots of garden and wild plants to malt wort [14]. The use of dry crushed berries and/or shoots of bird cherry, their infusions, juice, or syrup allows for partial replacing of hops and imparting specific flavor characteristics to beer [15,16].

In Asian countries, beer is produced by using aloe, tea, and mulberry extract, which delays the rise of glucose in blood [17]. In addition to the other mentioned beer additives, the use of fruit or berry juices is common worldwide.

Non-traditional additives used in beer production serve different purposes. Some perform technological functions, possessing bactericidal properties, facilitating wort clarification (juniper, ginger, yarrow, nuts, etc.), others form its organoleptic and physicochemical, sometimes pharmacological properties, soften the effect of alcohol on the body, increase the nutritional value of beer (products made by processing of fruits, berries, honey, citrus peel, herbs, roots, etc.) [18].

In the research presented, the technology of special beer based on clarified apple and grape juices has been developed. The choice of these raw plant materials was due to their wide availability and suitability for processing and production of high-quality fruit and berry semi-finished products. These fruits and juices obtained from them contain a significant amount of food acids, easily digestible carbohydrates, amino acids, microelements, and other nutrients necessary for the human body.

The availability of a sufficient number of apples and grapes, appropriate processing capacities, as well as many years of experience in the production of concentrated juices for long-term storage indicates that the production of beverages, including beer-based ones, using apple and grape juices in Kazakhstan is the most promising and economically justified.

Results and their discussion

The monitoring of scientific and technical information allowed for testing the following methods of special beer production using apple and grape juices as shown in Figure 1.

The first method allows for making a special beer by mixing finished beer with ready-made

juice. To determine the optimal beer to juice ratio in terms of organoleptic properties of the finished beverage, the samples of finished beverages were prepared using lager (with original wort extract of 12% and the level of bitterness equal to 1.0) and clarified apple and grape juices. The mixing was carried out according to the following beer to juice ratios: 70:30, 60:40, 50: 50, 40: 60, and 30:70.

When juices were added to the finished beer, turbidity of the beverage was observed, the intensity of which increased with an increase in the amount of introduced juice. Moreover, with the introduction of apple juice, the intensity of turbidity was higher than with the use of grape juice. The obtained samples were filtered on a kieselguhr filter. The physicochemical and organoleptic characteristics of the finished beer are presented in Tables 1 and 2.

The data in Table 1 indicate that with increasing amounts of apple juice, the pH of finished beer is reduced from 4.4 to 4.0, and the acidity increases from 2.2 to 2.8. The dry matter content increases from 4.2 to 6.3. The volumetric alcohol content drops from 3.5 to 1.5%. There is also a slight decrease in the level of head retention and foam formation.

A similar pattern was observed when grape juice was used, with the exception of the pH and acidity values, which were in a more acidic zone. The stability of the obtained samples does not exceed 10 days.

As shown in table 2, a simple mixing of the ready-made juice with the finished beer followed by filtration on a kieselguhr filter allows for obtaining a rather transparent product, dark red or amber-colored depending on the juice.

With an increase in the amount of introduced juice over 40%, the predominance of apple and grape juice flavors was revealed in the flavor and aroma of the beverages. Moreover, the flavor of the samples prepared with the use of grape juice showed an increased acidity of the beverages. All samples had excessive hop bitterness, which negatively affected the organoleptic characteristics of the obtained special beer samples.

Thus, the production of special beer using the first method is possible but the challenges related to both the colloidal stability and production of finished beverages that have coherent and balanced flavor and aroma have to be considered.

For the second method, the special beer samples were prepared with the beer made using traditional technology and an original wort concentration of 12%, using fermented apple and grape juices. In this case, beer samples were prepared by using *Oettinger Pils* yeast. Physicochemical indicators of special filtered beer samples prepared by this method are presented in Table 3.

The data indicate that the level of acidity and the pH of the beer obtained using apple juice and fermented by *Oettinger Pils* yeast race ranges from 2.4 to 2.8 and pH ranges from 4.40 to 4.70. Adding grape juice to beer changes acidity from 6.10 to 6.8 and pH from 3.3 to 4.0. The change in the mass fraction of the actual extract and the volume fraction of ethanol fluctuates depending on the ratio of the components used.

An almost threefold increase in the stability of the finished product (in comparison with special beer samples prepared using the method 1) can be explained by various substances, including pectin, been degraded and destroyed in the process of juice fermentation, which causes turbidity when mixed with finished beer. However, parameters such as foam height and head retention remained nearly the same. The organoleptic study of the obtained beverages showed that almost all samples had insufficiently balanced flavor and aroma: in one case, a predominance of malt flavor was noted, and in the other – fermented grape or apple flavor. Samples made of 50% beer + 50% fermented juice declared as the most balanced of all studied and had no pronounced aroma of a corresponding fruit juice.

Thus, the second proposed method of making special beer allows for producing beverages with sufficiently high stability, and the ratio of 50% beer + 50% fermented juice resulted in the most balanced indicators in terms of organoleptic characteristics were obtained.

Table 1 - Physicochemical indicators of special beer obtained by method 1

Wort / juice ratio	pH	Acidity	Mass fraction of the active extract	Alcohol content, %	Foam height, mm /foam retention, min	Stability expected, days
with apple juice						
70/30	4.40	2.20	4.20	3.5	20/2	10
60/40	4,30	2.40	4.70	3.0	20/2	7
50/50	4.20	2.50	5.20	2.5	15 / 1.5	8
40/60	4.10	2.60	5.80	2.0	15 / 1.5	7
30/70	4.00	2.80	6.30	1.5	15 / 1.5	7
with grape juice						
70/30	3.70	6.10	4.2	3.5	20/2	8
60/40	3.60	6.20	4.7	2.9	20/2	10
50/50	3.40	6.40	5.2	2.5	15 / 1.5	8
40/60	3.20	6.50	5.8	2.0	15 / 1.5	7
30/70	3.00	6,70	6,3	1.5	15 / 1.5	7

Table 2 - Organoleptic characteristics of special beer obtained by mixing finished beer with grape or apple juice

Wort / juice ratio	Organoleptic properties		
	colour	smell	taste
with apple juice			
70/30	amber	malty, subtle apple, with hop flavor	too bitter, malty, subtle apple flavor
60/40	amber	malty, subtle apple	too bitter, subtle apple flavor
50/50	amber	apple, malty	too bitter, malty, subtle apple flavor
40/60	amber	pronounced apple	too bitter, pronounced apple, subtle apple flavor
30/70	amber	pronounced apple	too bitter, strongly pronounced apple
with grape juice			
70/30	bright red	grape, malt flavor	too bitter, sour, grape with malt flavor
60/40	bright red	grape, malt flavor	too tart, sour, grape
50/50	dark red	pronounced grape	too tart, very sour, pronounced grape
40/60	dark red	pronounced grape	too tart, very sour, pronounced grape
30/70	dark red	pronounced grape	too tart, very sour, pronounced grape

Table 3 - Physicochemical indicators of special beer samples obtained by method 2

Yeast species and race	Beer to juice ratio	Indicator					
		pH	Acidity	Mass fraction of the active extract	Alcohol content,%	Foam height, mm /foam retention, min	Stability expected, days
with apple juice							
Oettinger Pils	70/30	4.70	2.40	4.6	4.40	35 / 2.5	30
	60/40	4.65	2.50	4.7	4.45	33 / 2.5	28
	50/50	4.60	2.60	4.9	4.50	30 / 2.5	30
	40/60	4.52	2.70	5.0	4.60	30 / 2.0	28
	30/70	4.40	2.80	5.1	4.65	28 / 2.0	28
with grape juice							
Oettinger Pils	70/30	4,00	6.10	4.6	4,00	37 / 2.5	30
	60/40	3.80	6.20	4.7	4.10	35 / 2.5	28
	50/50	3.70	6.30	4.8	4.20	35 / 2.5	30
	40/60	3.40	6.40	4.9	4.40	33 / 2.0	28
	30/70	3.30	6.80	5.0	4.50	30 / 2.0	28

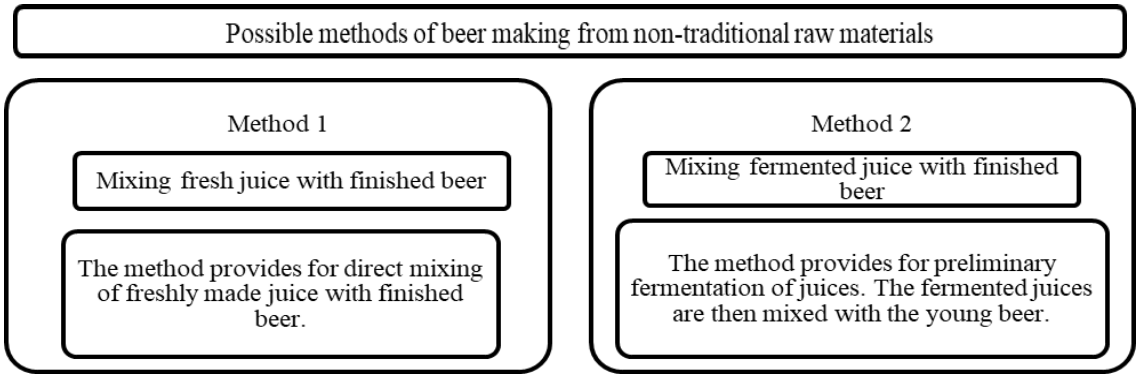

Figure 1 - Possible methods of making special beer

Conclusion

According to the research, two methods of special beer production using fruit and berry juices were selected. Both methods have their own special characteristics. Brewing the beer using the first method by introducing ready-made apple and grape juice into young beer after the post-fermentation stage results in a shorter technological process. The beer to juice ratio of 70:30 produces a beverage with a characteristic malt flavor and aroma and a trace of grape and apple juice. However, during storage, a colloidal instability of the beer produced using this method is revealed that is associated with the content of pectin substances in fruit and berry juices.

The second method when readily fermented bases of apple and grape juice are introduced into young beer at the stage of post-fermentation makes it possible to achieve high stability of the finished beverage. The 50/50 beer to juice ratio allows for obtaining the most balanced beverage in terms of organoleptic characteristics.

These results will allow revamping the technological equipment in breweries of different production volumes by attracting new target groups of consumers without using additional resources, thus increasing the range of products, producing special beverages and ensuring business growth.

Acknowledgments, conflict of interest (funding)

We would like to thank “IP Efes Kazakhstan” JSC for sponsoring the purchase of a NANO BREWERY TYPE 50 L4 mini brewery and establishing a fermentation products training and research center based on the Almaty Technological University. This contribution enables scientific experiments in craft brewing.

The authors declare that there are no conflicts of interest regarding this research, including those of a financial, personal, authorship or other nature that could affect the research and its results presented in this article.

REFERENCES

1. Kobelev V.K.(2003) Razrabotka spetsi-al'noy tekhnologii piva s ispol'zovaniyem frukto-vykh sokov[Development of special beer techno-logy using fruit juices]: dis... Ph.D. 05.18.07 / Moscow State University of Food Production.-M.: 2003.- 132 p.

2. Bauer D.A., Gorlova V.V.(2019). Proizvodstvo piva s ispol'zovaniyem plodovoyagod-nogo syr'ya Samarskoy oblasti[Production of beer using fruit and berry raw materials from the Sama-ra region] //*Tools for the effective development of modern science*. - PP. 59-61.

3. Kiselev I.V., Bespalova O.V., Lodygin A.D., Rudnev Yu.V.(2011) Innovatsionnaya tekh-nologiya nizkokaloriynogo svetlogo piva s ispol'zovaniyem ovsa i tsikoriya[Innovative technology of low-calorie light beer using oats and chicory] // *Beer and drinks*.-no. 6. – P.P.22-27.

4. Chusova A.E., Yuritsyn I.A. (2013). Razrabotka spetsial'nogo piva s ispol'zovaniyem yablochnogo soka [Development of a special beer using apple juice] // Agricultural sciences and agro-industrial complex at the turn of the century.- №. 1. – PP.52-56.

5. Mirella Nardini, Ivana Garaguso (2020). Characterization of bioactive compounds and antioxidant activity of fruit beers// Food Chemistry, Vol. 305.- PP. 245-253. https://doi.org/10.1016/j.foodchem.2019.125437

6. Joanna Kawa-Rygielska, Kinga Ada-menko. (2019) Physicochemical and antioxidative properties of Cornelian cherry beer// Food Chemistry, Vol. 281.- P. 147-153.

7. Gagiyeva L.CH., Tsugkiyev B.G., Dzantiyeva L.B. (2011). Tekhnologicheskiye aspekty ispol'zovaniya rastitel'nogo syr'ya v kachestve aktivatorov protsessov peregona [Technological aspects of the use of vegetable raw materials as activators of haul processes] // Beer and drinks. - no 6. - P. 28.

8. Faradzheva E.D. et al. (2011). Development of a beer-type beverage using unconventional raw materials //Beer and Beverages. – no 6. – P.P. 157-166.

9. Karpenko D.V., Lipatova M.A. (2020). Podkhody k rasshireniyu assortimenta slaboalkogol'nykh napitkov na zernovoy osnove [Approaches to expanding the range of grain-based low-alcohol drinks] // Colloquium-journal. - Golopristan regional employment center. – no. 12 (64). – P.P. 88-97.

10. Ivanchenko O.B., Danina M.M. (2018). Ispol'zovaniye lekarstvennykh trav v tekhnologii temnykh eley [The use of medicinal herbs in the technology of dark ales] // Bulletin of the IAC. - no 1.- PP. 66-78.

11. Kozlov N.Ye., Gavrilov S.V. (2020). Al'ternativnoye rastitel'noye syr'ye v proizvodstve piva [Alternative vegetable raw materials in the production of beer]// All-Russian scientific and technical conference with international participation "Equipment for food production in the XXI century." - P. 100.

12. Arkayev B.A. (2016). Ispol'zovaniye yakona i shalfeya v proizvodstve piva // Bulletin of scientific works of young scientists, graduate students and undergraduates of the Gorsky State Agrarian University.-P.P. 132-134.

13. Dunayev A.N. (2013). Obosnovaniye i razrabotka tekhnologii napitka na osnove pivnogo susla s dobavleniyem khvoynogo ekstrakta. [Substantiation and development of technology for a drink based on beer wort with the addition of coniferous extract].// Technique and technology of food production.-N 1.- PP. 3-7.

14. Kretova YU.I. (2017). Perspektivy ispol'zovaniya netraditsionnogo syr'ya v tekhnologii pivovareniya: otechestvennyy i zarubezhnyy opyt [Prospects for the use of non-traditional raw materials in brewing technology: domestic and foreign experience] // Bulletin of SUSU. Series "Food Biotechnology", № 4. – P.P. 12-18 .

15. Gernet M.V., Gribkova I.N. (2020). Vliyaniye soyedineniy khmelya i khmelevykh produktov na organolepticheskiy profil' gotovogo piva [Influence of hop compounds and hop products on the organoleptic profile of finished beer]// XXI century: results of the past and problems of the present plus. - Vol. 9. - no. 1. – P.P. 93-99.

16. Smol' YU.V., Velichko N.A. (2019). Retseptura spetsial'nogo piva s sokom yagod yezheviki i kostochki kostochki [Recipe for a special beer with blackberry juice and pits] // Science and education: experience, problems, development prospects. -P.P. 150-152.

17. Nesterenko Ye.A., Meledina T.V. (2010). Povysheniye antioksidantnoy aktivnosti piva pri upotreblenii zelenogo Chaya [Increased antioxidant activity of beer when drinking green tea] // Beer and drinks, No. 6.- P.P. 36-42.

18. Omel'chuk S. i dr. (2013). Razrabotka tekhnologii spetsial'nogo piva s ispol'zovaniyem ekstrakta gretskogo orekha [Development of technology for special beer using walnut extract]// Preservative Science, Engineering and Technology, vol.X. – P. 354−356.

19. State standard 29294-2014 (2016). Malt malt. Specifications. M.: Standartinform, - 26p.

20. State standard 32912-2014 (2016). Hop products. General technical conditions. M.: Standartinform, - 16p.

21. State standard 31711-2012 (2019). Beer. General specifications. Moscow: Standar-tinform, -12 p.

22. Baygaziyeva G.I., Uvakasova G.T., Kekibayeva A.K., Barmakov A.S. (2019). Me-tody analiza piva i bezalkogol'nykh napitkov [Methods for the analysis of beer and soft drinks]: Textbook-Nur-Sultan: Non-profit joint-stock company "Kasipkor Holding". - 120p.