Use of clarifying agents in technological process of kvass production

M V Osipova
Yaroslav-the-Wise Novgorod State University, 41, ul. B.Sankt-Peterburgskaya, Veliky Novgorod, Russian Federation
E-mail: sampaz@list.ru

Abstract. In our country, the production of soft beverages is a popular direction of food industry. Fermented kvass, fruit and berry drink, lemonade, carbonated drinking and mineral water, and others are referred to non-alcoholic drinks. Currently, consumers increasingly prefer natural drinks consisting of traditional ingredients. One of the traditional drinks since ancient times revered in Russia, is bread kvas of natural fermentation. In the production of fermented drinks, modern technologies, the newest equipment, automated manufacturing processes are used, which allow intensifying technological plots for fermented kvass production using new methods. This allows optimizing stages of technological process and the entire production. The use of new methods for optimizing production processes allows reducing costs of production by reducing the time component of the technological process of kvass production.

1. Introduction
Bread kvass is a traditional drink which has been prepared in Russia from ancient times. For many centuries the quality of kvass has been improved, new tastes, manufacturing ways and techniques have been sought for. As a result, by now we have received a wide range of natural fermented kvass [1].

In appearance, traditional bread kvass is a drink of dark brown color, sour and sweet taste, with pleasant characteristic flavor of rye bread. Traditional bread kvass is produced by fermenting kvass wort with baker’s yeast Saccharomyces cerevisiae and lactic acid bacteria Lactobacillus fermentum.

Enterprises produce a wide range of kvass differing to a certain extent only in the solids content. To produce kvass, a wide variety of raw materials are used: various types of malt (red rye, light barley, light wheat), rye, wheat and barley flour, sugar, maltose syrup [2, 3].

Taste and color of a live fermented drink are determined by the content of melanoidins of rye malt in it [4, 5]. Substances resulted from the fermentation process are responsible for aroma: diketones, complex ethers, aromatic higher spirits, etc. [6] The best combination of kvass wort ingredients is a mixture of 65% of rye malt, 10% of barley malt and 25% of rye flour. This combination allows obtaining kvass with a delicate taste and flavor corresponding to the taste of pure rye bread.

The easiest way followed by the majority of manufacturing plants is the use of fermentation of kvass wort concentrate in the kvass production technology. Frequently, this is a way out of the situation for manufacturers when they are unable to continuously brew the kvass wort using the existing capacities, or there is a dramatic lack of capacities of the brewing department of the enterprise. This makes the technology of kvass production easier, and eliminates the necessity of using evaporators to prepare the kvass wort concentrate. Evaporators are used in the process chain to create a supply of raw materials. This is especially true for large kvass brewing enterprises, which also produce beer wort at the brewing
facilities. The use of kvass wort concentrate allows producing kvass during the whole year as well as using brewing capacities in the autumn-winter period when the demand for kvass and beer traditionally falls.

Visually, the kvass wort concentrate is a thick viscous liquid of dark brown color with a characteristic pleasant rye bread flavor.

A whole series of kvass with plant extracts, and natural beer and fruit juices has been developed: with hibiscus (contains 6.3 mg /100 g of vitamin C), apple, horseradish, cranberry juice, mineral supplements complex containing micro- and macro-elements, vitamins [7].

There are several ways to prepare kvass wort. Depending on the raw material used, different methods of making wort are applied: infused or rational. These methods differ in the percentage of ingredients, and brewing techniques.

Kvass wort contains an insignificant amount of sugar (to 1%), for this sugar syrup (25% of the total) is added to the kvass wort before fermentation.

Kvass wort fermentation is performed at temperatures +28+30°C in containers under pressure: fermentation tanks, fermentation and blending devices (BKA) or cylinder-conical tanks (CKT).

The special feature of BKA (fermentation and blending devices) and CKT (cylinder-conical tanks) is that they have a slide gate to separate yeast from kvass after fermentation. When yeast precipitates into the lower part of a capacity, it may be removed without involving the kvass. This allows kvass to be blended in the same capacity in which fermentation was carried out. The top yeast is disposed of.

The advantage of CKT (cylinder-conical tanks) before BKA (fermentation and blending devices) is that they can provide the maximum microbiological process purity: their internal surface is well polished, they have washing heads, capacities are washed with alkaline, acid and disinfectant solutions at CIP stations without being taken apart. At the moment, CKT (cylinder-conical tanks) are the commonest equipment for kvass production. They are universal. At large kvass and beer brewing plants, after thorough washing and disinfection, they are used to produce other beverages, for example, beer or mead.

Fermentation process is provided by baker’s yeast and lactic acid bacteria. Lactic acid bacteria contribute to sour pleasant taste of kvass.

After fermentation kvass is chilled. When solids concentration decreases by 1 %, fermentation is stopped by lowering the temperature to +10°C. In the process, yeast and lactic acid bacteria precipitate to the bottom of the fermentation capacity, and enter the yeast separator. After separation of the yeast, kvass is blended with the remaining sugar syrup (75 % of the total sugar).

The obtained blend is mixed by stirrers, most often by the way of circulating through a pipeline using a pipe with the following return to the fermentation capacity through its upper part. Mixing is carried out until the mass fraction of solids becomes the same in the entire volume of the capacity. Control for this process is carried out by the way of sampling from a sampling tap.

Then the kvass is chilled to +2+6°C, clarified under pressure by the method of separation and/or filtration, and poured into containers. Fermented kvass is poured into various types of containers: glass bottles, PET bottles, aluminum cans, kegs.

Control of kvass production is performed by the same techniques of analysis of physical and chemical, microbiological, and organoleptic characteristics as that of beer production [8].

2. Results
Currently, a large number of breweries with modern equipment produce kvass [9]. So, such enterprises have everything necessary to produce fermentation kvass for a long shelf-life. Resistance of drinks depends on the amount of microorganisms in them, so, in order to prolong a shelf-life, it is necessary to remove as much of microorganisms as possible before bottling [10]. Due to the use of clarifying techniques, it is possible to increase the durability of fermented kvass for the period from 5 to 60 days. Clarifying can be achieved by stopping fermentation at the required stage, considering the amount of solids in the drink, and removing microorganisms from kvass.

For kvass clarifying there are several successive techniques:
• use of clarifying agents for the deposition of microorganism cells;
• filtration of clarified kvass on plate filters using various kinds of diatomaceous earth;
• filtration on sterilizing filters in the stream before pasteurization.

The first technique contributing to an increase in kvass durability to 7-10 days is the use of clarifying agents. This technique is simple and inexpensive.

Clarifying agents contribute to flocculation of yeast cells. Agents contain collagen which, while interacting with yeast and other kvass substances, forms conglomerates with them, which results in yeast settling down and drink clarifying. Yeast in the aggregate condition with particles of a clarifier forms a dense deposit at the bottom of the fermentation tank, which is separated well during pouring, resulting losses of the product in the liquid phase being minimal.

Several clarifiers are well known. In the food industry, Isinglass (Rusferment OOO (Limited Liability Company), Russia), Profain (Ekspoteh OOO (Limited Liability Company), Russia) are used.

Isinglass is a clarifying preparation used in the production of beer of bottom and top fermentation. This preparation is a powder of white or creamy color which consists of highly purified collagen isolated from swimming bladders and gills of fish of special breeds. Interacting with negatively charged yeast cells and positively charged protein particles of the preparation, they are attracted to each other and form large agglomerates which settle down to the bottom of a fermentation tank, impacted by gravitation. This allows speeding up the process of clarifying kvass.

The use of the Isinglass clarifying preparation allows significantly reducing the content of yeast cells in the finished kvass, and yeast loading on kieselguhr or sterilizing filters, increasing their filtering performance.

Using the Isinglass clarifying agent, it is possible to prolong the self-life of the product from several days to one-two weeks, which allows producing kvass in kegs without additional steps of filtration and pasteurization, reducing material and labor costs for its production. Kvass in kegs can be sold in small batches in cafes and restaurants.

The Isinglass agent is introduced into the finished kvass in the form of 1% of working solution after fermentation, after the necessary content of solids have been achieved, and the drink has been chilled to +5-7°C. The working solution of the agent is prepared by dissolving in water at the temperature +8-12°C, and thoroughly stirred. Then the kvass is left for 16-18 hours to be clarified. Finally, the kvass is poured out or filtered. The standard dose for the agent amounts to 0.2-0.5 g per a liter.

After clarification, it is possible to correct the content of solids in the kvass and its acidity by adding sugar syrup and citric acid.

The shelf-life of kvass and the preservation of its quality depend mainly on the content of yeast cells in the drink. After fermentation, it is necessary to remove as much yeast as possible for a longer shelf-life. To achieve this, kvass is clarified. This can be done either by adding clarifiers, separation or filtration.

At Deka AO (joint-stock company), Veliky Novgorod, two kvass parties were examined and compared in regard to clarifying using the Isinglass agent and the method of separation. Kvass samples were examined in an experimental production laboratory. Quality parameters determined for the assessment are presented in table 1.

An analysis of the data obtained showed that the kvass sample with the clarifier was superior to the separated sample by all parameters selected for the comparison. Thus, the amount of yeast cells after separation was 0.3%, and, after the use of the Isinglass agent, it was 0.2%.

Both kvass parties were filtered on a plate filter with different fractions of diatomaceous earth. The data analysis showed that the volume of the kvass party filtrate clarified with the Isinglass agent passing through the plate filter increased. Also, the filtration rate increased, and the filtration time was lengthened due to the ability to filter more kvass on one kieselguhr deposit.

A 20 % increase in the shelf-life of the kvass clarified with the Isinglass agent was noted, due to more complete separation of yeast cells.
Table 1. Kvass quality parameters.

| Parameter Description | Using a separator | Using a clarifying agent |
|------------------------|-------------------|--------------------------|
| Clarity, EBC units     | 0.7               | 0.5                      |
| The number of yeast cells before the process, million | 26.7 | 27.2 |
| The number of yeast cells after the process, million | 0.8 | 0.55 |
| Filtration rate l/min  | 0.8               | 1.5                      |
| The volume of flow of the filtrate, l/min * m | 375 | 585 |
| Biological resistance, days | 140 | 170 |
| Colloidal resistance, days | 160 | 190 |
| Shelf life, days       | 130               | 160                      |

Comparative degustation of samples of the kvass experimental parties was carried out. Organoleptic parameters are presented in table 2.

Table 2. Organoleptic parameters of kvass quality.

| Parameter Description | Value |
|-----------------------|-------|
| Using a separator     |       |
| Using a clarifying agent |     |
| 1. Appearance of clarified kvass | Clear or almost clear liquid; a small amount of sediment allowed |
| 2. Structure          | on the surface and in the thickness of kvass the presence of food flavoring fillers (cranberries, lingonberries, grated horseradish, etc.) allowed |
| 3. Color              | Due to the color of the raw materials used, from light brown to dark brown |
| 4. Taste and flavor   | The refreshing taste and aroma of the fermented drink, corresponding to the taste of pure rye bread or rye bread with a delicate aroma of the corresponding food-flavor fillers and the aroma of the raw materials used. Yeast flavor and aroma are allowed. |

The data analysis showed that organoleptic parameters of the experimental parties practically do not differ in all parameters selected for comparison.
3. Conclusion

Summing up, we may note that for the whole historical period of kvass production and up to no more than ten-fifteen years ago, kvass production was seasonal, mainly, in spring and summer, and depended on the vagaries of weather. Raw materials were processed seasonally, the main period of consumption was in a hot period, before the appearance of berries and fruits.

Also, the short period of kvass production depended on the short shelf life of kvass, up to two days. Such production was determined by the fact that kvass is the product of incomplete alcoholic fermentation, with a low alcohol content, and a relatively high solids content. In addition to nutrients, it contained a significant number of microorganisms, yeast, and, when using lactic acid fermentation, lactic acid bacteria as well. All this is a favorable environment for the continuation of fermentation processes. It should be considered that kvass was sold in the warm season, in street containers with kvass there occurred a re-fermentation, which had been initially stopped by cooling at enterprise. All this could lead to a decrease in kvass organoleptic characteristics. In that case, the question about a long shelf life could not arise, as whole kvass was usually sold in the first sales day.

The purpose of using the Isinglass clarifying agent is to increase the resistance of kvass during storage, improve its organoleptic qualities by reducing the risks of a possible secondary infection. The use of the preparation allowed producing kvass not only in auto-cisterns for street sales in spring and summer, but pouring it in containers (kegs, glass bottles, PET bottles) for year-round sales in cafes, restaurants, shops, and trading centers. All this resulted in high demand for kvass, rapid growth of capacities of manufacturing plants, appearance of new enterprises engaged only in kvass production, growth of capacities of existing breweries which began brewing also kvass wort and producing fermented kvass using the available equipment. Altogether, this allowed improving the taste of kvass, making it more pronounced and rich, speeding up and simplifying the technological process, prolonging a shelf life up to a year, reducing costs of fermented kvass production.

References

[1] Kiyashkina L A, Tsugkieva V B, Tokhtieva L Kh, Shabanova I A and Datieva B A 2018 Use of chokeberry in the production of kvass Bulletin of Voronezh State Agrarian University 57 (2) 124–30 DOI: https://doi.org/10.17238/issn2071-2243.2018.2.124

[2] Tanashkina T V, Peregoedova A A, Semenyuta A A and Boyarova M D 2020 Gluten-free buckwheat kvass with the addition of aromatic raw materials Technique and technology of food production 50 (1) 70–78

[3] Tanashkina T V, Semenyuta A A, Trotsenko A S and Klykov A G 2017 Gluten-free low-alcohol drinks from light and stewed buckwheat malt Technique and technology of food production 45 (2) 74–80 DOI: https://doi.org/10.21179/2074-9414-2017-2-74-80

[4] Ponomareva O I, Borisova E V and Prokhorchik I P 2018 Lactic acid bacteria of the genus Lactobacillus in the formation of the flavor profile of acidic ales Technique and technology of food production 48 (2) 100–08

[5] Medoro C, Cianciabell M, Camilli F, Magli M, Gatti E and Predieri S 2016 Sensory profile of Italian craft beers, beer taster expert versus sensory methods: a comparative study Food and Nutrition Sciences 7 (6) DOI: https://doi.org/10.4236/fns.2016.76047

[6] Dongmo S N, Sacher B, Kollmannsberger H and Becker T 2017 Key volatile aroma compounds of lactic acid fermented malt based beverages – impact of lactic acid bacteria strains Food Chemistry 229 565–73 DOI: https://doi.org/10.1016/j.foodchem.2017.02.091

[7] Shkolnikova M N, Zavorokhina N V and Chugunova O V 2017 On the issue of increasing the nutritional value of kvass. Bulletin of SUSU (South Ural State University). Series “Food Biotechnology” 5 (2) 93–99 DOI: https://doi.org/10.14529/food170212

[8] Lorenzo C P, Zannini E and Arendt E K 2016 Lactic acid bacteria as sensory biomodulators for fermented cereal-based beverages Trends in Food Science & Technology 54 17–25 DOI: https://doi.org/10.1016/j.tifs.2016.05.009

[9] Chekina M S, Meledina T V and Khlynovskiy M D 2015 Development of technology for mashing
oat malt *Beer and drinks* 6 44–48

[10] Chereda A S, Kostyleva E V, Velikoretskaya I A and Tsurikova N V 2018 Use of a multi-enzyme preparation based on the Trichoderma reesi strain in the production of oat wort *Beer and drinks* 4 72–74