AGRISCIENCE AND TECHNOLOGY
Armenian National Agrarian University
ԱԳՐՈԳԻՏՈՒԹՅՈՒՆ ԵՎ ՏԵԽՆՈԼՈԳԻԱ АГРОНАУКА И ТЕХНОЛОГИЯ
International Scientific Journal
ISSN 2579-2822

Journal homepage: anau.am/scientific-journal
doi: 10.52276/25792822-2022.2-212

UDC 663.42

Developing Technology for Special Beer Brewing by Using Non-Traditional Raw Materials

H.Zh. Ter-Movsesyan
Armenian National Agrarian University
termovsesyan@gmail.com

ARTICLE INFO

Keywords:
special beer,
brier hips,
brier juice,
technology,
physicochemical indicators

ABSTRACT

The current work aims to justify special beer production technology developed through brier hips and juice. Availability of abundant species of brier hips and juice production industry in the Republic of Armenia enables to use them as non-traditional raw materials for beer brewing. The studies have shown that the most rational way of using brier juice is to add it at beer maturation stage after main fermentation. The most complete, consistent and inherent beer taste has been formed when combining 70 % young beer and 30 % brier juice. Brier hips were added 5 minutes before the end of boiling wort with hops. The best indicators have been recorded in the samples where 0.5 kg brier hips per 1 dal hopped wort has been added.

Introduction

Efficient use of raw materials is one of the prerequisites for the development of beer and non-alcoholic beverage industry. Besides saving the raw material, it is also necessary to improve the product quality and expand its range. Alcoholic beverages produced by using plant extracts not only improve in taste, but also mitigate the adverse toxic effects of ethanol (Gernet, 2009). In recent years, the direction of developing beer manufacturing technology by applying raw materials from medical plants has been actively advanced.

Non-traditional raw materials for brewing are spices, herbs, fruits, berries, medical plants, and wild yeast that can convey unusual flavor and aroma characteristics (Danina and Ivanchenko, 2015). To produce drinks with specific properties and high nutritional value, various herbs, roots, nuts, fruits and berries are also added to the beer (Schilcher and Loew, 2013).

Honey is widely used in the production of special beers in many countries. It is added into the wort as a source of easily fermentable carbohydrates, or after fermentation into the finished beer product in amount of 1-3 % (Hahn, 2000). Beer additives can perform various functions: technological, pharmacological, nutritional. Nowadays, a technology for special beer manufacturing with addition of extracts from the Far Eastern wild plants of Araliaceae family has been developed (Palagina, et al., 2010).

Currently, significant growth in the production of low-

alcohol and soft drinks is observed, which encourages manufacturers to increase production size and range of the mentioned beverages. Manufacture of the mentioned drinks is a newly developed market branch which becomes more and more widespread among the consumers. So, the development of a technology by using non-traditional raw materials would promote the enhancement of the demanded products range. In Armenia, there is a growing interest in setting up small breweries in small towns and rural areas. Thus, the conducted research can serve as a base for the development of a new beer product manufacturing technology with innovative methodologies in Armenian breweries.

The current work is devoted to the justification of implementing special beer technology developed through brier hips and juice. Availability of great number of brier hips species (31 types), as well as production of juice in the Republic of Armenia, enables to use them as non-traditional raw materials for beer brewing. It is worth mentioning that brier hips have volatile and strong bactericidal properties. They also contain large amounts of antioxidants, but the most important thing is that brier hips come forth as a valuable multivitamin source.

Materials and methods

Throughout the research experiments traditional raw materials for the preparation of beer wort and yeast strains necessary for obtaining new type of beer has been selected. Brewing malt, brier hips, drier juice, barley, pale malt, aromatic hop pallets, brewer yeast of Saccharomycetes race and water have been used in manufacturing the new beer product. Experimental studies were carried out in the laboratory of the Chair of Plant-Based Food Product Processing Technology, as well as at the «Beer of Yerevan» Closed Joint-Stock Company.

The technology of discussed special beer manufacture is based on the traditional beer brewing technology and consists of the following main steps:

1. *Preparation of raw material:* in this stage special attention was paid to crushing, which was implemented by means of laboratory mill.

2. *Mashing:* mashing was carried out via infusion method. The resulted mash was heated at a rate of 1^0C per minute with pauses for optimal enzyme action. During pauses, the mash was stirred uninterruptedly. Termination of saccharification process was checked with an iodine test. After a positive reaction to saccharification, the beer was sent for filtration. Mashing mode is shown in the Figure 1.

3. *Wort filtration:* the first wort was returned again to the filtration to refine it maximum thoroughly. Then the grains were washed with water and the washings were mixed with the wort.

4. *Boiling the wort with hops:* when boiling the wort with hops, evaporation of excess moisture, extraction of aromatic and bitter substances of hops, coagulation of high-molecular proteins, inactivation of enzymes and sterilization of the wort is observed. Boiling duration of wort with hops ranged from 1.5 to 2 hours.

5. *Cooling and clarification of the wort:* the hot beer wort was cooled and filtered. The wort was cooled in a refrigerator to a temperature of 7 ± 1^0C. Thereinafter, yeast was added to wort.

6. *Fermentation of beer wort:* in the current research, fermentation process was carried out in closed glass vessels. The main fermentation process lasted 7 days. Fermentation was carried out according to a certain temperature schedule, planned by the technological scheme, with daily monitoring of fermentation temperatures. After reaching an extract content of 4.0-3.5 %, the fermented wort was cooled to a temperature of 3-5 ^{0}C. The decrease in temperature was carried out slowly -1^0C during three hours. Thus, cooling of young beer took up to 12 hours. After reaching a temperature of 3 ^{0}C, young beer was left at this temperature for another 12 hours for better yeast settling.

7. *Maturation of beer:* The following main processes take place during maturation: saturation of beer with carbon dioxide, clarification due to the precipitation of yeast sediment and suspended particles, maturation. Maturation of beer was carried out at a temperature of 0-2 ^{0}C without oxygen. During maturation, the beer was kept in the apparatus for 21 days, after which the finished beer product was sent for filtration and bottling.

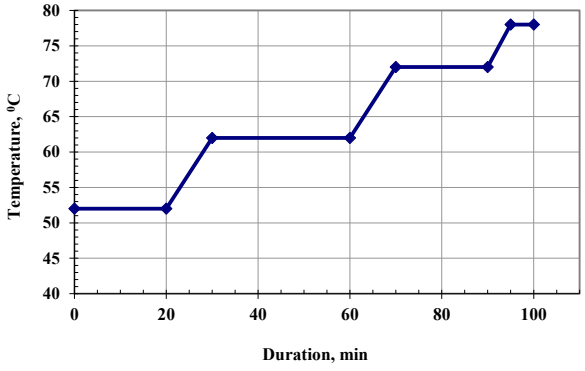

Figure 1. Mash temperature chart *(composed by the author)*.

Results and discussions

The traditional beer manufacturing technology served as a background for the special beer production upon brier hips and juice supplementation. There are four possible options regarding the relevant time when the mentioned ingredients can be added: adding brier hips and juice to the wort at the stage of boiling wort with hops, at fermentation stage, maturation stage or adding them to the finished beer product. According to the research results and theoretical data, it is better to add brier juice after the main fermentation and at the stage of maturation. Addition of brier juice to the finished product caused turbidity, appearance of suspensions and discoloration. In such beer samples woody taste profiles were recorded. Whereas, adding brier juice at the brewing stage with hops would significantly reduce the quality of finished product, since when boiling the wort with extract and hops, a significant loss of vitamin C and other useful compounds is observed. Thus, brier juice should be added after the main fermentation parallel to the young beer maturation, which will ensure avoiding loss of juice aromatic substances, that could occur when adding juice at the stage of boiling wort with hops.

The studies have shown that the use of brier juice at the main fermentation stage again caused loss of some aromatic substances and tannins. In the result, hazy beer with opalescence was produced. Besides, it has been proved that addition of extracts at the main fermentation stage reduced yeast activity and slowed down the fermentation process. Thus, investigations have shown that the most rational way of using brier juice is to add it at the maturation stage, after main fermentation. So, the selected method for beer brewing is based on the above stated findings.

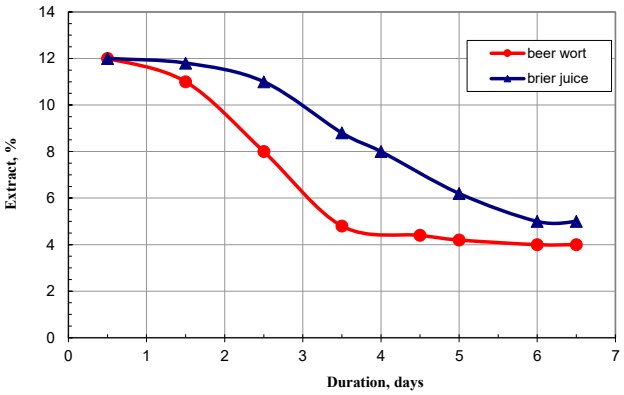

Figure 2. Fermentation dynamics of beer wort and brier juice via beer yeast *(composed by the author)*.

Malted hopped wort with 12 % initial concentration was prepared according to the infusion method. The main fermentation and maturation took place in line with traditional technology except that before fermentation young beer was mixed with brier juice with a certain ratio. The ratio of 70 % young beer and 30 % brier juice made it possible to obtain beer drink samples with pleasant malt-brier flavor, the aroma of which is balanced with malt and brier tones. The produced special samples of beer drink are distinguished by high foam stability and foam height. The further research was related to the study of yeast fermentation dynamics of beer wort and brier juice. Fermentation dynamics of beer wort and brier juice via beer yeasts is introduced in Figure 2.

For beer production, brewer's yeasts of various races are used. The use of these yeasts is due to the fact that they convey peculiar taste and aroma to beer; besides, they are conformed to beer production conditions and composition of beer wort. Using brewer's yeast for fermenting brier juice was of particular interest, the latter being used for special beer manufacturing. In this regard, it is necessary to study the organoleptic and physicochemical indicators of fermented products. Initial concentration of dry matters in wort and juice makes 12 %. Fermentation was carried out at a temperature of 8 ^{0}C for 7 days. The values of pH, acidity and dry matters of brier juice and beer wort were the researched parameters. The research results are presented in the Table. During the beer wort fermentation pH value decreases to 3.70, which indicates that acids are formed throughout fermentation, while pH of brier juice practically does not change in fermentation process, only by the end decreasing to the level of 3.46.

Table. Physical and chemical indicators of fermented products*

Fermentation duration, day	pH		Dry matters, %		Acidity, acid value	
	Brier hips juice	Beer wort	Brier hips juice	Beer wort	Brier hips juice	Beer wort
1	3.70	5.52	12	12	4.8	2.3
2	3.62	5.50	11.6	10.6	4.9	2.4
3	3.60	5.06	11.0	8.4	5.0	2.5
4	3.58	4.80	9.2	4.9	5.3	2.6
5	3.52	3.78	7.3	4.7	5.5	2.7
6	3.50	3.75	5.3	4.6	5.7	2.8
7	3.46	3.70	5.1	4.3	5.8	2.9

*Composed by the author.

As regard to the reduction of dry matter content, it is obvious that beer wort was fermented more intensely than brier juice since fermentation was carried out with brewer's yeast. It has been revealed that with combined fermentation, brewer's yeast does not affect the organoleptic indicators of the manufactured product.

The further research activities are related to the development of technological scheme for new beer product manufacture by using brier hips. They can be applied at various stages of beverage production, such as boiling the wort with hops, main fermentation and maturation stages, but it is most relevant to add them when boiling the wort with hops for better extraction of aromatic substances available in the raw material, and to replace part of the hops with another raw materials, like brier hips.

Dry brier hips were added five minutes before the end of boiling the wort with hops and similarly aromatic hops were added so as to preserve flavoring components. Mashing was carried out through infusion method. When boiling the wort samples with dry brier hips, half of aromatic hops were added 30 minutes before the end of boiling, and then 5 min before the end of boiling aroma hops and brier hips were added. For control sample 50 % of aromatic hops was added 30 minutes before the end of wort boiling, the second half – 5 minutes before its end. After boiling the wort was cooled and hoppy wort was filtered, then the content of dry matters was investigated. Afterwards the wort was transferred into fermentation apparatus. During fermentation monitoring over the fermentation rate of the extracted substances was carried out by measuring dry matters through refractometric method.

Conclusion

Based on the research results, new non-traditional raw materials and technological scheme for special beer production has been recommended. Brier hips and juice has been selected as non-traditional raw materials. The developed technology for manufacturing new beer products by using non-traditional raw materials puts special stress on the following aspects: the wort should be prepared through infusion method, while the initial concentration of dry matters in the hopped wort should make 12 %.

The studies have shown that the most rational way of using brier juice is to add it at the stage of maturation, after main fermentation. The physicochemical parameters and quality indicators of the finished product showed that the most complete, consistent and inherent beer taste has been recorded in the samples with the addition of 70 % young beer and 30 % brier juice.

It should be noted that in the samples with brier juice addition fermentation process was weaker than that of in the samples with brier hips. Brier hips were added at the stage of boiling wort with hops 5 minutes before the end of boiling. The best results were recorded in the samples where 0.5 kg brier fruits per 1 dal hopped wort has been added. As a result, beer drink samples with pleasant malt-brier flavor and balanced aroma of malt and brier tones have been manufactured. The use of plant-based extracts in the production of special beers will expand the market of physiologically healthy beverages.

References

1. Danina, M.M., Ivanchenko, O.B. (2015). The Use of Brettanomyces Yeasts in Beer Technology. Bulletin of the International Academy of Refrigeration. N 4, - pp. 27-31 (in Russian).
2. Gernet, M. V. (2009). State and Perspective Manufacture of Special Beer Varieties. Beer and Beverages. N 2, - pp. 8–10 (in Russian).
3. Hahn, P. (2000). Energy Drinks and Functional Drinks. N 4, - pp. 218-223.
4. Palagina, M.V., Zimba, A.G., Makarova, A.A. (2010). Development of Technology for New Special Beer Production via Addition of Vegetable Extracts, Innovation Technologies, N 4, - pp. 30-32 (in Russian).
5. Schilcher, H., Loew, D. (2013). Herbal Medicines Alternative to Synthetical Medicines, MMW Fortsch Med., N 16, - pp. 97-99.

Accepted on 12.04.2022
Reviewed on 27.04.2022