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АНАЛИЗ КАЧЕСТВЕННЫХ ПОКАЗАТЕЛЕЙ СИДРА, В ЗАВИСИМОСТИ ОТ ТЕХНОЛОГИЧЕСКИХ РЕЖИМОВ

ANALYSIS OF QUALITATIVE INDICATORS OF CIDER, DEPENDING ON TECHNOLOGICAL MODES

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Аннотация. *Слабоалкогольные напитки из натурального сырья широко распространены по всему миру, известными примерами являются вина и сидр. Такие показатели, как содержание сахара и спирта в процессе производства имеют важное значения. В результате чего исследование в данной области представляет широкий спектр возможностей внедрения инновационных технологий в производство.*

Материалы и методы. *Рассмотрен традиционный процесс производства слабоалкогольного напитка – сидр. Представлен обзор методов исследования с помощью измерительного прибора, рефрактометра. Подробно описан процесс брожения. Так же представлен вниманию метод исследования содержания сахара и спирта с помощью виномера. Представлены обработанные результаты экспериментальных данных.*

Результаты и обсуждения. *Проведён физико-химический анализ содержания сухих веществ, а так же показателя преломления с помощью рефрактометра. На основании полученных данных построены графики зависимостей рассматриваемых показателей от температурного режима брожения. Так же представлены зависимости содержания сахара и спирта от температуры брожения сидра.*

Заключение. *С увеличением потребительского спроса на слабоалкогольные напитки, рассматриваются более эффективные и менее затратные методы на их производство. Увеличиваются требования к производимой продукции. В данной работе рассмотрены основные методы анализа продукта, применяемые в процессе его производства.*

Ключевые слова: сидр, рефрактометр, брожение, спирт, виномер, сухие вещества.

Abstract. *Low alcohol drinks made from natural raw materials are widespread throughout the world, well-known examples are wine and cider. Indicators such as sugar and alcohol in the manufacturing process are important. As a result, research in this area presents a wide range of possibilities for introducing innovative technologies into production.*

Materials and methods*. The traditional process of producing a low-alcoholic beverage, cider, is considered. A review of research methods using a measuring device, refractometer is presented. The fermentation process is described in detail. A method for studying sugar and alcohol content using a wine meter is also presented. The processed results of the experimental data are presented.*

Results and discussions. *A physicochemical analysis of the solids content, as well as the refractive index using a refractometer, was carried out. Based on the data obtained, graphs of the dependences of the considered indicators on the temperature regime of fermentation are constructed. The dependences of sugar and alcohol on cider fermentation temperature are also presented.*

Conclusion. *With an increase in consumer demand for low alcohol drinks, more effective and less costly methods for their production are considered. Requirements for manufactured products are increasing. This paper discusses the main methods of product analysis used in the process of its production.*

Key words: cider, refractometer, fermentation, alcohol, wine meter, solids.

Introduction. Cider is a low-alcohol drink made from the fermentation of apple juice. In the production of cider, apple varieties are used in which tannin is present. The apple varieties in question are cultivated specifically for the production of this drink. Depending on the organoleptic characteristics, the considered varieties can be divided into four main groups: sweets, sharps, bittersweets and bittersharps. The presented varieties differ in the amount of sugar, in taste and in other organoleptic characteristics.

The purpose of the research is to study the effect of temperature conditions on the intensity of fermentation.

Materials and methods. In the traditional production scheme for such a low-alcohol drink as cider, apples are used. The first stage of manufacturing is the preparation and grinding of the product. At the next stage, the juice is squeezed out, after which it is filtered. Then the resulting juice is sent to fermentation vats, the duration of this process takes about two weeks, depending on the apple variety. After that, the drink is clarified and cleaned of impurities. One of the objects of research in this work is the analysis of the quality indicators of cider, depending on the technological mode of fermentation. The stages of cider production were carried out according to a typical scheme, consisting of the following operations.

1) The apples were stored for 2-3 days in a warm room. This was done in order not to wash away wild yeast from the surface of the fruit, which is needed for fermentation.

2) The leaves and stems were removed. Apples in the amount of 2.2 kg, together with the peel and seeds, were crushed with a juicer.

3) Mix the juice with the crushed apples and stir until smooth.

4) Divide the homogeneous mixture into two parts. Each mixture obtained had a mass of 1.1 kg.

5) 0.16 kg of sugar was added to each mixture.

6) Then the resulting mixtures were left to ferment for 2 days.

7) After 2 days, the juice was squeezed out of the fermented mixture and each mixture was placed for further fermentation at different temperature conditions.

For two weeks, fences were taken and the percentage of dry matter and the refractive index were examined. These studies were carried out using a refractometer shown in Figure 1 [1].

A refractometer is an optical device, one of the purposes of which is to measure the specific gravity of a liquid. To carry out this measurement, a few drops of liquid are taken and its optical properties are examined. The refractometer is widely used in the wine-making and brewing fields.

Also, thanks to the refractometer, the specific gravity of the obtained liquids is monitored. At this point, it is a good alternative to a hydrometer, and often these two methods are used together, for more accurate readings [2].

One of the main advantages of a refractometer in comparison with a hydrometer is the small volume of liquid required for research.

When examining pure water in terms of optical characteristics, there is a certain deviation that occurs due to the transmission of light. The deflection resulting from the passage of light through a transparent medium, in our case water, is called refraction. Moreover, when light passes through other substances, its deviation will deviate from the standard by a certain value [3].

When sugar-containing substances are added to water, there is an increase in the deviation of light from its original value. A refractometer uses this effect, resulting in a quantitative determination of sugar in the test sample due to the amount of deflection of light.

The light source can be either a lamp that illuminates the sample under study or natural light in the room. These features depend on the characteristics of the refractometer [4].

Two alcoholic beverages of the same composition, cider, fermented at different temperature conditions were investigated. First sample of cider was fermented at 20 °C, the second – at 27 °C.

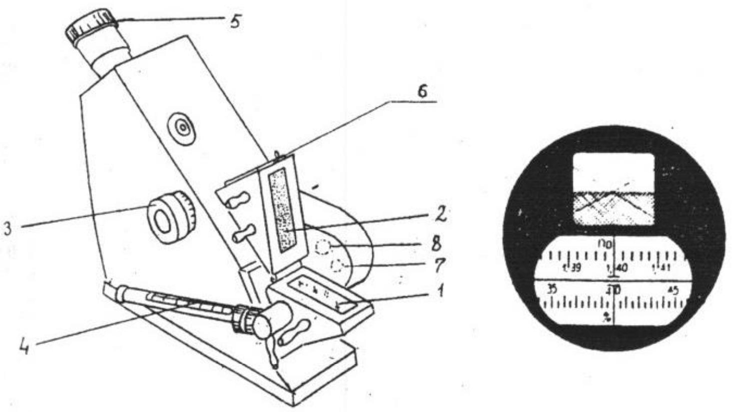

Fig. 1. Refractometer

When working with a refractometer, the following guidelines should be followed. The first thing to do is check the zero point setting in the refractometer. It should be remembered that the setting of the zero point, as well as the measurements carried out on the refractometer, must be carried out at the same temperature conditions. Checking and setting the zero point should be carried out with distilled water [5]. As a result of the study of distilled water, the required light and shade limit should be on a division equal to 1.33299 on the refractive index scale and 0% on the dry matter scale. Checking and setting the zero point is carried out according to the following plan:

– move the upper chamber and rinse the surfaces of the measuring and lighting lenses with alcohol, then wipe the surface dry with a clean cloth;

– apply a few drops of distilled water with a pipette on the measuring surface of the lens and close the previously opened chamber;

– moving the illuminator, direct the light beam to the lens of the upper camera;

– by rotating the handle with the eyepiece along the scale, find the chiaroscuro border;

– the found border of chiaroscuro, rotating the handle, combine with the hairline. With the correct setting of the zero point, the light-shade border will pass beyond the refractive index scale equal to 1.33299 and then 0% of the dry matter scale [6].

In the course of the work, a study was also carried out, as a result of which the dependence of the change in the amount of sugar during fermentation was measured. This dependence is due to a decrease in the amount of sugar, as a result of which the amount of dry matter decreases, as well as the refractive index.

Thus, in the first sample, fermentation proceeded at a temperature of 20 ° C, and in the second sample, the temperature was 27 ° C. The study was conducted over two weeks, during which fences were taken and changes in the amount of sugar and alcohol were observed [7].

Alcoholic fermentation is a process, as a result of which, under the influence of yeast, a qualitative reaction of converting glucose into ethyl alcohol and carbon dioxide occurs in an anaerobic environment. The equation for the described reaction is shown below:

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2.$$

As a result of this reaction, one glucose molecule is split into two molecules of ethyl alcohol and two molecules of carbon dioxide. Also, the result of the reaction is a small release of energy, under the influence of which there is a slight increase in the temperature of the medium. It should be noted that during the fermentation process, fusel oils are also formed that negatively affect the finished product: butyl, amyl and other alcohols, which are by-products of the exchange between amino acids [8].

Yeast is a spherical, single-celled fungus. The substance in question has the peculiarity of actively developing in a liquid medium, which in turn is rich in sugars. In this study, we used naturally-produced yeast that forms on the surface of apples.

The main factors for the development of yeast are the amount of sugar, temperature and acidity of the environment. An additional influence is exerted by the presence of the necessary macro- and microelements, the percentage of alcohol, as well as the access of the environment to oxygen [9].

1. The amount of sugar required for stable fermentation should be kept in the range of 10-15%. When sugar concentration exceeds this value, fermentation weakens.

2. The optimum temperature for the yeast should be 20-27 ° C. Since at significantly lower values, the fermentation process slows down significantly.

3. The acidity of the medium should be maintained in the range of 4.0-4.5 pH. At this value, the medium is acidic, which favorably affects alcoholic fermentation.

4. Ethyl alcohol has a double effect on the fermentation process. First of all, it is a necessary product for the life of yeast. At the same time, ethyl alcohol is a strong toxin, which slows down the fermentation process. Empirically, it was calculated that for the formation of approximately 0.6% alcohol, 1% sugar is needed. Thus, to achieve a result of 12% alcohol, a solution is needed, the sugar content of which will be 20%.

5. In an anaerobic environment, the so-called survival of yeast occurs, in which the maximum amount of alcohol is released. Thus, in order to protect the wort from the ingress of oxygen into it, as well as to provide removal of carbon dioxide, a water seal is used [10].

Within the framework of this work, the dependences of the dry matter content and the refractive index on the temperature regime in which the fermentation process takes place will be obtained. The results obtained give an idea of the reaction rate. Thus, it is possible to monitor the consumer properties of the product at the stage of wort fermentation.

Also as a result of this work, the dependences of the percentage of sugar and alcohol on the fermentation temperature of the wort were obtained. That allows you to adjust the modes of the technological process.

Results and discussions. As a result of the research, the data were obtained, after analyzing which the table 1 was constructed. This table reflects the dependences of the content of dry substances and the refractive index on the I and II t° modes, which correspond to 27°C and 20°C, respectively.

Table 1

Values of the refractive index and the amount of dry matter during fermentation

Reasearch №	1	2	3	4	5	6	7
I t° mode							
Solids content,%	19,2	15,1	10,8	8,9	8,9	8,9	8,2
n_d	1,3625	1,3552	1,349	1,346	1,344	1,342	1,341
II t° mode							
Solids content, %	20	17,8	15,4	13,9	13,1	12,5	12
n_d	1,363	1,36	1,356	1,354	1,352	1,351	1,351

Analyzing the data from Table 1, visual graphs were built that fully reflect the resulting dependence. Figure 2 and Figure 3, respectively, show the changes in dry matter and refraction indicators during wort fermentation.

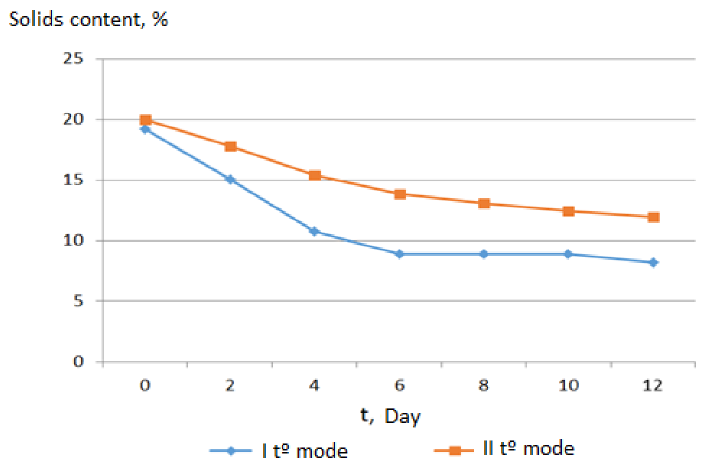

Fig. 2. Changes in the dry matter index during fermentation

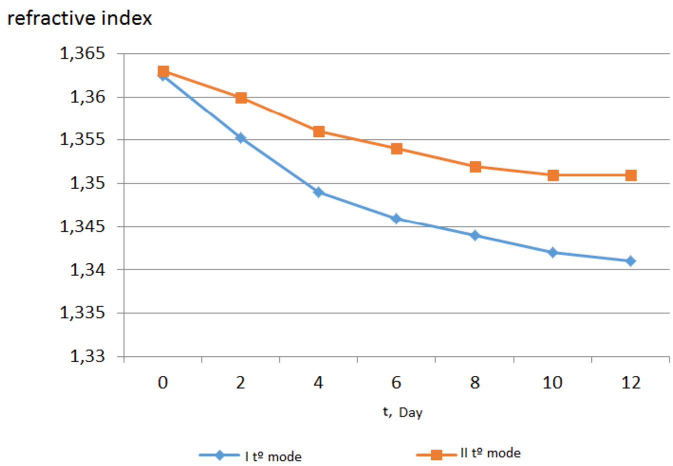

Fig. 3. Change in refractive index during fermentation

After analyzing the data obtained, we can conclude that with the classical scheme for making a low-alcohol drink from apples, the optimal values that allow the use of the drink according to GOST are achieved: during fermentation at a temperature of 27 °C - this indicator corresponds to the 2nd dimension (2 days after the start of fermentation). At 20 °C, this indicator corresponds to the 3rd dimension (4 days after the start of fermentation).

The research results for cider fermented at I and II temperature regimes are presented in Table 2. The presented table reflects the dependence of the sugar and alcohol content on the temperature under the influence of which fermentation proceeds.

Table 2

Values of indicators of sugar and alcohol

Reasearch №	1	2	3	4	5	6	7
I tº mode							
Sugar content,%	21	11	5	4	3	0	0
Alcohol content,%	3	5	9	11	12	12,5	12,5
II tº mode							
Sugar content,%	21	20	15	12	10	10	9
Alcohol content,%	1,5	2,1	5	6	8	8	9

Analyzing the data from Table 2, visual graphs were built that fully reflect the resulting dependence. Figure 4 and Figure 5 respectively show the changes in the sugar and alcohol content in the samples under consideration.

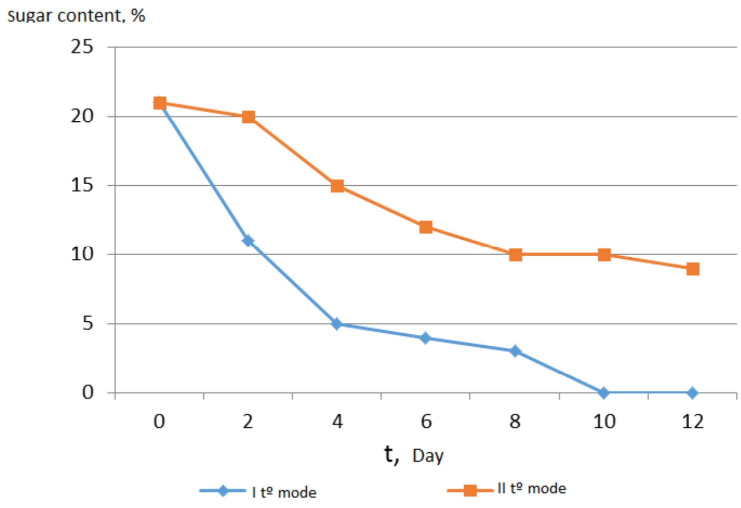

Fig. 4. Sugar content in samples

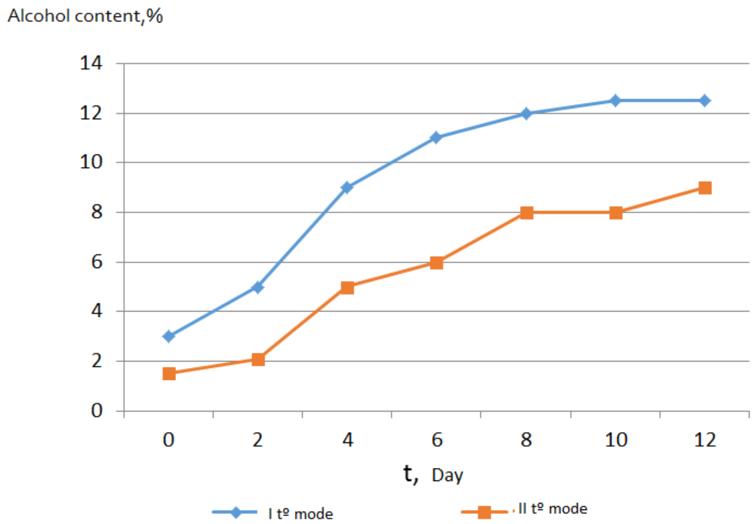

Fig. 5. Alcohol content in samples

As can be seen from the graphs, at II t° mode, yeast stops processing sugar at an alcohol content of 8%. At the I t° mode, the yeast processes sugar completely in 2 weeks. The last measurement corresponds to 0% sugar and 12.5% alcohol content.

Conclusion. Based on the results of the work, the dependence of the intensity of fermentation on its temperature regime was established. Thus, the optimal fermentation temperature is 26-27 °C. Exceeding this temperature regime is impractical, as this will lead to the death of yeast fungi. Lowering the temperature regime, in turn, inhibits the development of yeast, which leads to a slowdown in the fermentation process.

Based on the results of the work, the dependences of the content of dry substances and the refractive index on the temperature regime of wort fermentation have been established. Also presented are graphs reflecting the obtained dependencies.

When carrying out the research, the optimal indicators for wort fermentation were revealed. At a temperature of 27 °C, this figure corresponds to 2 days after the start of fermentation. At 20 °C, this figure corresponds to 4 days after the start of fermentation.

Thus, as a result of the work done, it was determined that the increased temperature significantly accelerates the fermentation process, thereby increasing the productivity of the enterprise.

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