ИССЛЕДОВАНИЕ ПОКАЗАТЕЛЕЙ КАЧЕСТВА ПРОДУКТОВ СМЕШАННОГО БРОЖЕНИЯ

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Аннотация
В данной статье проведен анализ органолептических, физико-химических и микробиологических показателей, определения содержания водорастворимых витаминов кефирных продуктов, полученных на основе смешанного брожения из коровьего и козьего молока. Образцы готового продукта выдерживают при температуре 12±2 °C для дальнейшего созревания в течение 12 часов. Определено количество этилового спирта, молочной кислоты и углекислого газа, образующихся в кефирных продуктах при созревании.

Особую ценность представляют кисломолочные напитки, полученные в результате смешанного брожения. В процессе молочнокислого и спиртового брожения количество лактозы уменьшается, а количество молочной кислоты, этилового спирта и углекислого газа увеличивается.

Полученные кефирные продукты по качеству не уступали традиционным кефiram. Кислотность в продуктах не превышала показатель кислотности в стандарте для кефира в конце срока хранения. Таким образом, анализ литературных данных и результатов исследований позволяет сделать вывод о том, что полученные кефирные продукты являются пищевым продуктом с очень важными пробиотическими свойствами, способствующими общему здоровью организма.

Ключевые слова: смешанное брожение, кефирный продукт, молочная кислота, этиловый спирт, углекислый газ, дрожжи, пробиотические микроорганизмы.

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INVESTIGATION OF QUALITY INDICATORS OF MIXED FERMENTATION PRODUCTS

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Abstract
This article analyzes organoleptic, physical-chemical and microbiological indicators, determines the content of water-soluble vitamins in kefir products obtained on the basis of mixed fermentation from cow's and goat's milk. Samples of the finished product are kept at a temperature of 12±2 °C for further maturation for 12 hours. The amount of ethyl alcohol, lactic acid and carbon dioxide formed in kefir products during maturation was determined.
Fermented milk drinks obtained as a result of mixed fermentation turns out to be particularly valuable. In the process of lactic acid and alcoholic fermentation, the amount of lactose decreases, and the amount of lactic acid, ethyl alcohol and carbon dioxide increases.

The resulting kefir products were not inferior in quality to traditional kefirs. The acidity in the products did not exceed the acidity standard for kefir at the end of the shelf life. Thus, the analysis of literature data and research results allows us to conclude that the obtained kefir products are a food product with very important probiotic properties that contribute to the overall health of the body.

**Keywords:** mixed fermentation, kefir product, lactic acid, ethyl alcohol, carbon dioxide, yeast, probiotic microorganisms.

In recent years, there has been a special interest among consumers in traditional mixed opening products. The variety of microflora, special taste characteristics and therapeutic and preventive properties make these products popular. Interest in fermented milk drinks containing probiotic microorganisms (bifidobacteria, acidophilic bacilli and other microorganisms) is growing among the population.

Worldwide, there is a steady trend in the production and consumption of functional food products, most of which are lactic acid probiotic products. These products, containing microorganisms and microbial substances, have a beneficial effect on the physiological functions and biochemical reactions of the human body by optimizing its microbiological condition. Biological products with a mixed fermentation process, which use both lactic acid bacteria and yeast, are essential for proper nutrition.

The global lactic acid beverage market is a growing sector of the food industry as today's consumers actively consume products that improve well-being and reduce the risk of disease. In particular, the global market for functional foods and beverages grew 1.5 times between 2012 and 2018 and is expected to grow another 22.8% between 2018 and 2025, with a forecast market size of €21.7 billion. Dairy products make up about 43% of the functional market and it mainly consists of lactic acid drinks [1].

Among the lactic acid drinks obtained as a result of mixed fermentation, kefir traditionally retains leadership. Recently, the popularity of kefir has been increasing in Europe, Japan and the United States, which may be due to its proven probiotic properties and the positive effect of kefir on some diseases of the gastrointestinal tract. Kefir normalizes the work of the urinary system: it increases diuresis, affects nitrogen metabolism, contributes to an increase in the release of its products, and also removes urea, phosphates and chlorides from the body [2].

Kefir is a unique natural yeast – a product of the mixed lactic acid and alcoholic fermentation process prepared in kefir mushrooms. Kefir is valued not only for its taste and refreshing properties, but also for its benefits for the whole body [3,4].

Different types of microorganisms are found in natural symbiosis in kefir mushrooms. In fact, kefir mushrooms are a symbiosis of heterofermentative microflora: lactic acid mesophilic streptococci, aroma-producing streptococci (as a result of their development, they produce aromatic substances), mesophilic and thermophilic bacilli, acetic acid bacteria (contribute to the formation of viscous sludge) and yeasts (produce alcoholic fermentation provides).

Yeast produces not only alcohol fermentation, but also vitamins of group B, antibiotic substances capable of suppressing the development of tuberculosis bacilli and other pathogenic microorganisms. Yeast residues activate the development of lactic acid bacteria [5].

The process of obtaining kefir yeast is very difficult and takes a lot of time. Therefore, many enterprises refuse to produce kefir from natural yeast and use modern - live yeast. This resulting fermented milk product cannot be called kefir, it is a kefir product. Kefir can be called a product prepared in kefir mushrooms according to traditional technology without adding pure cultures of lactic acid microorganisms and yeast [6].

The dairy industry mainly produces cow's milk and products based on it. Today, the domestic market of dairy products is developing rapidly. Currently, the production of goat milk products with special metabolic and physiological characteristics is increasing [7]. Therefore, it is important to increase the number of goat milk products on the market.
The purpose of the research work is to study the quality indicators of kefir products made from cow's and goat's milk obtained on the basis of mixed fermentation.

**Materials and methods**

For the development of kefir products obtained as a research object, cow and goat's milk grown at the private farm «Karshaga» located in the village of Kokkainar, Shu district, Zhambyl region, was taken. The animals raised in the farm are always under veterinary and zootechnical control.

Commercial yeast «Vivo Kefir» was used as yeast, which, according to labeling data, contains: kefir yeast, Lactococcus lactis, Streptococcus thermophilus, Leuconostoc mesenteroides, Lactobacillus acidophilus, Bifidobacterium lactis, Lactobacillus delbrueckii ssp. Bulgaricus, Lactococcus lactis ssp. Lactis.

Milk fermentation technologies were carried out according to the manufacturer's recommendations. 2 samples were taken as research object:

- Sample №1 – is a kefir product made from cow's milk;
- Sample №2 – is a kefir product made from goat's milk.

Analysis of kefir product samples taken for research was carried out by the scientific research institute «Food Biotechnology» and «Food Safety» of Almaty Technological University.

Organoleptic indicators of samples of kefir products were determined by «MEMST 31454-2012 Kefir. Technical requirements» [8].

Titration acidity was determined by titration with 0.1N NaOH solution with phenolphthalein expressed in degrees Turner according to GOST 3624-92 [9].

Presence of carbon dioxide (CO2). To determine CO2, pour 20 ml of the product into a test tube with a diameter of 15 mm, mark the level, put it in a water bath with cold water, gradually bring the temperature of the water to 90°C, then remove the test tube and mark the level of the sediment (if the product contains CO2, then the sediment is spongy and rises from 6 mm of serum to 20-30 mm or more).

The amount of ethyl alcohol was determined by the pycnometric method according to GOST 3629-47 (with changes №1) [10].

Water-soluble vitamins were determined using the Capel-105 capillary electrophoresis system. Microbiological indicators of kefir products were analyzed according to GOST [11-15].

The experiments were repeated 5-7 times. Tables and figures show average arithmetical values of physico-chemical, microbiological indicators of studied kefir product samples.

**Research results and analysis**

The general technology of kefir products fermented under laboratory conditions is shown in Figure 1 below.
There are certain requirements for milk from which kefir products are obtained. According to organoleptic and physico-chemical quality indicators, it should comply with the standard [16,17]. Milk samples selected by quality are pasteurized at a temperature of 90±2 °C for 2-3 minutes.

Then it is cooled to a temperature of 28±2 °C and yeast is added. After adding the yeast, the mixture is thoroughly mixed for 10 minutes and fermented for 10-12 hours at a temperature of 28±2 °C. Then the resulting clot is kept at a temperature of 12±2°C so that the process of further maturation takes place. At this time, yeast development is activated, as a result of which alcohol, carbon dioxide and othersubstances accumulate in the product, giving the drink special properties. Then the product is mixed according to the requirements of the current specifications and stored at a temperature of 4±2 °C.

Organoleptic analysis is a qualitative and quantitative evaluation of product properties by human senses. Perception takes place with the help of the senses of sight, touch, smell and taste. Through organoleptic assessment, you can get a first idea about the nutritional value and partial safety of the product. In order to produce a new type of fermented milk products, the evaluation of the quality of experimental samples is carried out by evaluating their organoleptic and physico-chemical indicators, the results of which are shown in Table 1 below.
Table 1 – Comparative indicators of kefir product samples

<table>
<thead>
<tr>
<th>Product type</th>
<th>Cooking time, hours</th>
<th>Acidity, °T</th>
<th>Taste and smell</th>
<th>Organoleptic indications</th>
<th>Color</th>
<th>Storage time, day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kefir product from cow’s milk</td>
<td>10-12</td>
<td>94</td>
<td>Lactic acid, pleasant, without foreign taste and smell</td>
<td>The clot is intact, with a small amount of gas bubbles, the consistency is homogeneous. The serum is slightly separated.</td>
<td>Slightly yellowish, uniform</td>
<td>7</td>
</tr>
<tr>
<td>Kefir product from goat milk</td>
<td>10-12</td>
<td>101</td>
<td>There is a slight yeast taste, a characteristic smell of goat milk</td>
<td>A good intact clot with a small number of bubbles, the consistency is homogeneous.</td>
<td>Milky white, uniform</td>
<td>5</td>
</tr>
</tbody>
</table>

Samples of kefir products had a homogeneous consistency with a pleasant refreshing lactic acid, slightly yeasty taste and smell. This sense of taste and smell is due to the presence of lactic acid, alcohol, carbon dioxide and other substances, which are the products of the activity of lactic acid bacteria and yeast in kefir products.

The organoleptic properties of kefir are formed as a result of alcohol fermentation, therefore, the effect on the dynamics of alcohol fermentation during maturation process of kefir products was studied at the next stage. After fermentation, kefir product samples were kept for 12 hours at 12±2 °C for maturation. In the process of maturation, a gradual increase of yeasts and accumulation of metabolic products of microorganisms took place. At the end of maturation process, titration acidity was 110-120 °T. The dynamics of alcohol formation during maturation process of kefir products is shown below (Figure 2).

![Figure 2 – Dynamics of alcohol formation](image)

Figure 2 shows that fermentation takes place as a result of yeast growth during maturation. At the same time, during maturation, the alcohol content of the research samples gradually increases, and after 24 hours, the mass fraction of ethyl alcohol in the kefir product obtained from cow's milk reaches 0.08%, and in the kefir product obtained from goat's milk reaches 0.1%.

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Further study of the dynamics of fermentation showed that the amount of carbon dioxide increases simultaneously with the accumulation of alcohol in the product (Figure 3).

After 24 hours, the level of sedimentation was 7 mm in sample №1 and 8 mm in sample №2, thus indicates the release of carbon dioxide during the fermentation process.

The development of lactic acid bacteria leads to further fermentation of lactose and the formation of lactic acid. As lactic acid accumulates, the titration acidity of the products changes. It should be noted that the accumulated lactic acid inhibits the development of gas-forming fat and other unpleasant bacteria. Lactic acid does not only give the drink a certain taste, but also determines its dietary and preventive properties, activates the release of digestive enzymes in the intestinal tract and enhances their action. It also improves the body's absorption of phosphorus, calcium, iron and vitamin D.

During the research, the mass fraction of lactic acid in the studied kefir product samples was determined, the result is shown in Figure 4 below.
The results of the study showed that the mass fraction of lactic acid released over time during maturation increases, after 24 hours it was 1.39% in sample №1 and 1.48% in sample №2. In the course of the research, the analysis of water-soluble vitamins in the samples of kefir products made from cow and goat milk was carried out, the results are presented in Figures 5, 6 and Table 2 below.

Table 2 – Amount of water-soluble vitamins in kefir

<table>
<thead>
<tr>
<th>Vitamins</th>
<th>Sample №1</th>
<th>Sample №2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B_1$ (thiamine)</td>
<td>0.033±0.007</td>
<td>0.047±0.009</td>
</tr>
<tr>
<td>$B_2$ (riboflavin)</td>
<td>0.02±0.008</td>
<td>0.42±0.176</td>
</tr>
<tr>
<td>$B_3$ (panthenic acid)</td>
<td>0.20±0.040</td>
<td>0.33±0.066</td>
</tr>
<tr>
<td>$B_6$ (pyridoxine)</td>
<td>0.021±0.001</td>
<td>0.35±0.07</td>
</tr>
<tr>
<td>C (ascorbic acid)</td>
<td>0.16±0.054</td>
<td>0.42±0.143</td>
</tr>
</tbody>
</table>
Based on the data presented in Table 2, it can be concluded that the amount of C and B group vitamins in kefir product samples confirms its high therapeutic and preventive properties. It was found that the products contain a large amount of vitamins (group C, B) that ensure the normal course of biochemical and physiological processes in the human body. It can be seen that the kefir product made from goat's milk contains more vitamins than the kefir product made from cow's milk.

In the course of the research, microbiological analyzes of samples of kefir products were carried out. The number of viable lactic acid bacteria in kefir products was determined, they should be at least $1 \times 10^7$ CFU/cm$^3$(g), in yeast – at least $1 \times 10^4$ CFU/cm$^3$(g). The results of microbiological analysis are presented in Table 3 below.

<table>
<thead>
<tr>
<th>Microbiological indicators</th>
<th>According to regulatory documents</th>
<th>Sample №1</th>
<th>Sample №2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactic acid bacteria</td>
<td>CFU/cm$^3$ (g), not less</td>
<td>$1 \times 10^7$</td>
<td>$3.8 \times 10^8$</td>
</tr>
<tr>
<td>Yeast, CFU/cm$^3$ (g),</td>
<td>not less</td>
<td>$1 \times 10^4$</td>
<td>$1.2 \times 10^5$</td>
</tr>
</tbody>
</table>

The results of the analysis presented in the table, shows that the number of lactic acid bacteria in the kefir product made from cow's milk is $3.8 \times 10^8$ CFU/cm$^3$(g), and in the kefir product made from goat's milk – $2.4 \times 10^7$ CFU/cm$^3$(g); and the amount of yeast was $1.2 \times 10^5$ and $2.3 \times 10^5$ CFU/cm$^3$(g), respectively.

During the entire storage period, the total number of lactic acid bacteria and yeast changes slightly, and at the end of the shelf life, it corresponds to the norms of lactic acid drinks with a mixed type of fermentation.

**Conclusion**

The resulting kefir products are not inferior in quality to traditional kefir. At the end of the period, the acidity of the products did not exceed the standard acidity index for kefir. Factors that directly affect the quality of kefir products during maturation have been identified. Thus, the analysis of literature data and research results allows us to conclude that kefir products are a very important probiotic food product that contributes to the overall health of the body.

**References:**


