

Наводяться результати досліджень з визначення впливу йодовмісної добавки Еламіну в технології кефіру із козиного молока. Встановлено, що йодовмісна добавка впливає на підвищення рівня аміно- та жирних кислот у кефірі. Визначено раціональні концентрації Еламіну, що сприяють інтенсифікації процесу молочнокислого бродіння та скороченню часу утворення щільного згустку

Ключові слова: кефір із козиного молока, молочна суміш, йодовмісна добавка, Еламін, амінокислоти, жирокислоти

Приводятся результаты исследований по определению влияния йодсодержащей добавки Эламин в технологии кефира из козьего молока. Установлено, что йодсодержащая добавка влияет на повышение уровня аминокислот и жирных кислот в кефире. Определены рациональные концентрации Эламина, способствующие интенсификации процесса молочнокислого брожения и сокращению времени образования плотного сгустка

Ключевые слова: кефир из козьего молока, молочная смесь, йодсодержащие добавки, Эламин, аминокислоты, жирокислоты

DEVELOPMENT OF A TECHNOLOGY WITH AN IODINE-CONTAINING ADDITIVE TO PRODUCE KEFIR FROM GOAT MILK

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1. Introduction

It is known that goat milk compared to cow milk is characterized by much higher contents of fat, protein, minerals, and vitamins that can extend the range of dairy products for diets. However, the consistency of kefir from goat milk is inferior to the density of the product made from cow milk. Moreover, the time of coagulation in milk drinks that are fermented from goat milk is longer than for fermented products from cow raw milk.

None of the known methods of producing kefir from goat milk meets the parameters that are characteristic of the product from cow milk. Therefore, until nowadays, an urgent problem is to create cost-effective technologies of making kefir from goat milk.

2. Literature review and problem statement

An important task in providing the population with balanced nutrition is to develop a technology of making food products with a direct physiological effect. The most promising tendency is considered to be the creation of food based on traditional techniques and recipes.

Kefir is one of the most popular dairy drinks in the food intake by the population of Ukraine, which does not require large material costs for its production [1].

The raw material for producing kefir is usually cow milk, but it contains casein 1S- α , which often causes allergic reactions. Therefore, the recent efforts of scientists and technologists have been focused on studying alternative raw materials such as goat milk.

Goat milk fully meets the needs of the human body for nutrients, macro and micro elements. The amounts of calcium, vitamins, and some minerals in goat milk several times exceed those of cow milk [2].

Given the imbalance of nutrition intake, including lack of iodine, of the population, it is important not only to produce but also to enrich milk products with various substances, including trace elements.

The newest developments in food processing, new types of food additives and the increasing demands for health care have incited the need to improve the regulatory framework for food products [3].

Kefir and its water-soluble polysaccharide, kefiran, were both tested for antimicrobial and cicatrizing activities against several bacterial species and *Candida albicans* by using an agar diffusion method. Experiments were conducted

on skin healing of Wistar rats with induced skin lesions and *Staphylococcus aureus* inoculation. It was found that both kefir and kefiran showed some activity against all harmful microorganisms tested (*Escherichia coli* and butyric acid bacteria). The highest activity was against *Streptococcus pyogenes*. The kefir gel produced a protective effect on the connective tissue of the rats' damaged skin. The 7-day treatment enhanced the wound healing compared with applying 5 mg/kg of a neomycin-clostebol emulsion [4].

The antitumor activity of kefir (YK-1) made from cow milk was researched on this milk product manufactured in the Caucasus. It was determined that YK-1 in oral doses of 100 or 500 mg/kg inhibited the solid tumor of Ehrlich ascites carcinoma (EAC) when transplanted subcutaneously into mice. These results lead to the conclusion that YK-1 has an antitumor effect [5].

It should be noted that in Ukraine there are specific conditions for the emergence and development of abnormalities of the thyroid gland caused by iodine deficiency, long-term radioactive contamination, and a lack of iodine deficiency prevention at the state level. Therefore, adding organic forms of iodine to functional foods is especially important in iodine deficient regions [6].

A unique food additive of natural origin is Elamine, which is an extract of the seaweed *Laminaria*. It not only provides with iodine but produces a positive effect on overall health and metabolism. Moreover, Elamine is a stimulant of lactation. Its high content of iodine contributes to the process of synthesis of the thyroid hormone – a prolactin synergist [7].

There is a method of obtaining soured milk products from goat milk according to which the nutritional value of goat milk products is improved by adding fruit sugar, fructose, as a carbohydrate supplement to the normalized milk mixture before its pasteurization [8].

Another known method of making kefir from goat milk entails using skimmed cow milk powder (SCMP) as a food additive. This protein-carbohydrate supplement contains a concentrated form of casein and milk sugar (lactose), respectively. The supplement is added to the milk mixture in an amount of 2.0...2.5 mass % [9].

Chegen, among other national dairy products (such as kumis, kurunga, and ayran), is recommended as a valuable therapeutic and preventive drink in cases of tuberculosis, a secretion disorder of the motor function, gastrointestinal tract diseases, and during recovery. It has been determined that vitamins B₂, B₁, B₅, and B₉ in chegen can satisfy the daily needs for vitamins by 97, 84, 102 and 100 %, respectively. However, the content of essential amino acids in this drink slightly exceeds its content in kefir [10].

It has been shown that the use of the biologically active food supplement Laktumin can improve the organoleptic, physical, chemical and microbiological parameters of kefir Tyam-tyam made from goat milk for children. As a result of making the kefir, the amount of lactic acid bacteria in the experimental kefir batch was 1×10^9 CFU/g. After 5 days of storage, this figure remained almost the same, but in the controlled batch of the product, it had decreased [11].

It has been found that when 40–60 % of skimmed cow milk in the milk base for manufacturing baby food kefir is replaced with goat milk, the fermented clusters have high organoleptic properties as well as normalized physical, chemical and rheological parameters, whereas with an increased mass fraction of goat milk in the mixture, the clots

acquire a plastic texture, a slight flavor of goat milk, and a low liquid-binding capacity [12].

It has been proposed to use a carbohydrate-protein supplement – fruit sugar (fructose) – in producing kefir. Fructose is the honey sugar that increases the nutritional value of the product but adds some sweet taste which is foreign to this type of product; it also reduces the viscosity of the coagulate substance, which worsens its density and the resulting consistency [8].

Skimmed milk powder (SMP) as a food additive slightly reduces the excessive sweet flavor of this type of product. However, it produces a taste of over-pasteurization [9].

The close alternatives of kefir in terms of the curative properties are chegen from cow milk [10] and the kefir for children Tyam-tyam [11], made from goat milk. The therapeutic and prophylactic properties of the latter were ensured by using the biologically active food supplement Laktumin. However, chegen as a fermented milk drink produced in private farms does not have stable high-quality properties.

The developers of the technology of producing the children's kefir Tyam-tyam do not explain the physical and chemical structure or the mechanism of action of the additive Laktumin. That is why the high level of lactic acid bacteria in the experimental batch of the children's kefir (1×10^9 CFU/g) raises further questions.

The problem of increasing the density of clots in fermented goat milk while producing kefir as baby food was solved by mixing it with skimmed cow milk in an amount of 40–60 %.

At the same time, the authors point to the shortcomings of the product when increasing the mass fraction of goat milk in the formula. These shortcomings include getting plastic consistency and reduced liquid-binding capacity of the fermented milk clots [12].

Besides, in the mixture of the two kinds of milk having different technological properties (in terms of heat resistance, cheese-making capacity, etc.) there appears a shade of gray.

Moreover, due to the different costs of goat milk and cow milk (goat milk is more expensive), their mixing is frequently associated with counterfeiting.

Thus, the heterogeneity of the kefir consistency in color (possibly due to including conglomerates of skimmed milk powder and the reaction of melanoidization) deteriorates both the organoleptic properties of the product and its merchandising characteristics.

Scientists pay attention to the problem of iodine deficiency in the food intake of the population of Ukraine [6] and propose a way to overcome it. In particular, they mention the unique dietary supplement of natural origin – Elamine [7].

However, all the above-mentioned technological approaches used by inventors to improve the quality of kefir and its nutritional value have several disadvantages: sweet taste, patchy color due to conglomerates of milk powder, and a gray shade. Moreover, addition of the aforementioned food supplements to kefir makes it impossible to enrich kefir with organic iodine.

3. The aim and objectives of the study

The aim is to improve the technology of kefir making from goat milk that is enriched with the iodine-containing supplement Elamine as a means of preventing the disease of goiter among the population of Ukraine.

The aim was achieved by doing the following tasks:

- to study the physical and chemical properties of the iodine-containing supplement Elamine;
- to determine the amino acid composition of the iodine-containing supplement Elamine as to the content of essential amino acids;
- to perform a comparative analysis of the value of the amino acid score of Elamine in comparison with the FAO/WHO scale.

4. Materials and methods of researching raw goat milk, kefir based on it, and the iodine-containing supplement Elamine

4. 1. Sampling of milk from dairy goats and methods of physicochemical and biochemical research

To determine the physical, chemical and biochemical parameters of goat milk, there were selected groups of 10 goats each.

Goats of the second and third lactation, which were kept on the goat farm of the Education and Production Center of Kharkiv State Veterinary Academy (Mala Danylivka, Derhachiv District, Kharkiv Oblast, Ukraine), were clinically healthy.

Samples of milk from the goats on the farm were selected in proportion to the daily milk yield for 2 adjacent days. The samples of milk were filtered and cooled to a temperature of 6 ± 2 °C. They were brought for studying to the testing center of the Institute of Animal Breeding and Genetics of the National Academy of Agrarian Sciences of Ukraine (Kulinichi Village, Kharkiv Oblast, Ukraine), accredited in accordance with the requirements of GOST ISO/EC 17025:2006 (ISO/IES 17025: 2005, Accreditation Certificate 2T621 by the National Accreditation Agency of Ukraine).

The samples of milk taken from the groups of goats from the above-mentioned region of Ukraine were tested for determining their properties such as the mass fraction of fat, protein, lactose, density, and powder substances by Bentley-150.

The physical and chemical properties of the milk samples were determined in accordance with the requirements set forth in the following regulations:

- the dairy products were sampled as required by ISO 4834:2007 “Milk and dairy products. Acceptance, selection, and preparation of samples for control” and by ISO 707:2002 “Milk and dairy products. Guidelines for sampling”;
- the appearance, texture and color of the product were evaluated visually, whereas the taste and smell were determined organoleptically;
- the temperature complied with ISO 6066:2008 “Milk and dairy products. Methods of determining temperature and net mass”;
- the somatic cell count was performed using the combined model device Somacount-150 and the device Bentley-150 (Certificate of IDA 0001461-1 of 16 Dec. 2004 SCC);
- the titrated acidity corresponded to GOST 3624-92 “Milk and dairy products. Titrimetric methods for determining acidity”;
- the active acidity was determined by measuring the pH of the milk and milk products in the universal device of the pH type – 222;
- the mass fractions of moisture and dry matter in the kefir were determined according to GOST 3626-73 “Milk

and dairy products. Methods for determining moisture and dry substances”.

4. 2. Biochemical methods of analyzing goat milk and kefir thereof

The biochemical properties of the samples were determined according to the research requirements set forth in the below-listed regulations and by using instrumental techniques and devices:

- the mass fraction of fat was measured according to GOST 5867-90 “Milk and dairy products. Methods for determining fat” and ISO 1211:2002 “Milk. Gravimetric method for determining fat content” (Control method);
- the content of amino acids was determined according to the requirements of ISO 13903:2005 “Animal feed. The method for determining amino acid content”;
- the content of free fatty acids was specified by using the fatty acid chromatograph analyzer Chrome-5 according to GOST 30418-96 “Vegetable oils. The method for determining fatty acid composition”;
- the mass fraction of total protein was determined by the Kjeldahl method in accordance with ISO 8968-1 and ISO 8968-5.

4. 3. Sanitation research methods

The sanitary properties of the research samples were determined in accordance with the requirements set forth in the below-listed regulations and procedures as well as by certified devices:

- the preparation of the samples and the dilutions for microbiological tests were carried out in accordance with ISO IDF 122C:2003 “Milk and dairy products. Preparation of samples and dilutions for microbiological research”;
- the total amount of lactic acid bacteria was measured according to ISO 7999:2015 “Food products. Methods for determining lactic acid bacteria”;
- the total contamination of milk and milk products (Quantity of Mesophilic Aerobic and Facultative Anaerobic Microorganisms, QMAFAnM) was determined according to ISO 7089:2009 “Milk and dairy products. The method of counting the number of mesophilic aerobic and facultative anaerobic microorganisms, yeast and mold fungi by using plates”;
- coliform bacteria (*Escherichia coli*, *E. coli*) were accounted for according to ISO 7140:2009 “Milk and dairy products. The method of counting the number of coliforms and *Escherichia coli* (*E. coli*).

5. The results of studying the physicochemical and biochemical parameters of Elamine and goat milk kefir

Goat milk, normalized by the mass fraction of fat, is pasteurized in an amount of 1,000 kg. Then it is supplemented with the ready-to-use Elamine in an amount of 1 kg of the iodine-containing additive for 1,000 kg of the normalized milk mixture.

For this purpose, Elamine in the amount of 1 kg is mixed in a separate container with a bit of water or milk to 10 mass % at a temperature of 60 ± 2 °C and kept so for 30...40 min at a temperature not lower than 40...43 °C.

During the time, the mixture is periodically stirred.

Milk for making kefir is purified and then pasteurized at a temperature of (88 ± 2) and with exposure for 30 min-

utes. Next, the milk is supplemented with the ready-to-use iodine-containing additive and mixed. After stirring, it is homogenized. Homogenization is carried out at a temperature of pasteurization or above 55 °C and at a pressure of 15±2.5 MPa. The homogenized milk mixture with the iodine-containing additive is cooled to the fermentation temperature of 20...25 °C; then a kefir starter from swabs of kefir fungi is added in an amount of 1...3 %. It is possible to use the production starter in an amount of 3...5 % by the mass of the milk.

Fermentation is carried out for 6 hours until the formation of a dense clot with acidity of 85...100 °T.

The following technological operations are performed in accordance with the technological instructions for the production of kefir from cow milk.

The physical and chemical properties of the iodine-containing additive Elamine are listed in Table 1.

Table 1

The results of the physicochemical tests on the iodine-containing supplement Elamine

Properties	The contents of natural substances
Moisture, %	6.11
Ash, %	4.09
Crude fat, %	0.66
Crude protein, %	5.49
Crude fiber, %	3.45
BER, %	80.20
Calcium, %	1.293
Phosphorus, %	0.156
Copper, mg/kg	0.612
Manganese, mg/kg	0.915
Iron, mg/kg	3.42
Iodine, mg/kg	554

Table 1 shows that Elamine contains a balanced set of micro and macro elements in an organically bound form. The contents of iodine, phosphorus, calcium, and iron are several times higher than in other types of food.

The amino acid composition of the iodine-containing supplement Elamine by the content of essential amino acids and the amino-acid score value, compared with the FAO/WHO scale, is listed in Table 2.

Table 2 shows that according to the FAO/WHO scale the scores of all essential amino acids of the iodine-containing supplement Elamine (threonine, valine, methionine+cystine, isoleucine, leucine, phenylalanine+tyrosine, and tryptophan) exceed those of the ideal protein by 15.5, 19.6, 17.1, 32.5, 17.3, 176.4 and 37.0 %.

The only exception is the amino acid lysine, the score of which was by 28.5 % less compared to the same property of the ideal protein.

This indicates that protein of the iodine-containing supplement is of a full balanced value as to the contents of essential amino acids.

The experimental batches of kefir were produced from goat milk by the following parameters as to the mass frac-

tion (mass %) of fat – 4.21 % and protein – 3.07 % and an active acidity of pH of 6.72 units. The physical and chemical properties of kefir that was made by the traditional and the proposed methods of production are shown in Table 3.

Table 2

The amino acid composition of the iodine-containing supplement Elamine by the content of essential amino acids and the amino-acid score value, compared with the FAO/WHO scale

Amino acid	FAO/WHO scale, mg in 1 g of protein	AA content in mg in 100 g of the DS (5.85 % of protein)	AA content in mg in 1 g of the DS protein	Score, %
Threonine	40.00	270.0	46.2	115.5
Valine	50.00	350.0	59.9	119.6
Methionine+cystine	35.00	240.0	41.0	117.1
Isoleucine	40.00	310.0	53.0	132.5
Leucine	70.00	480.0	82.1	117.3
Phenylalanine+tyrosine	60.00	970.0	165.8	276.4
Lysine	55.00	230.0	39.4	71.5
Tryptophan	10.00	80.0	13.7	137.0
Total essentials	360	2,930.0	501.1	1,086.9

Table 3 shows that the production of kefir by the traditional method, using skimmed milk powder as a food additive in an amount of 2 mass %, increases the fat content by 0.08 %, compared to (Sample 1) kefir without using it.

The production of kefir by the method proposed in this study, with the iodine-containing supplement Elamine as a food additive to a milk mixture in an amount of 0.05 mass % to 0.16 mass %, increased the fat content of kefir from 4.18 % to 4.38 %, compared to the same property in kefir (Sample 1) produced without the use of the dietary supplement, or by 0.98...1.18 %.

The mass fraction of protein in kefir that is made by using the protein-carbohydrate supplement (SMP, Sample 2), compared with kefir without it (Sample 1), increased by 0.06 %.

The use of the iodine-containing supplement Elamine in an amount of 0.05 mass % to 0.16 mass % helped increase the mass fraction of protein from 2.93 % to 3.32 %, compared with the same property of kefir without using food additives (Sample 1) by 0.08...0.47 %.

Table 3 also shows that the mass fraction of fat in kefir with the iodine-containing additive Elamine in the amounts of 0.10...0.15 mass % (Samples 5–7), exceeds the same property of kefir that was made by the traditional method of production with SMP (Sample 2) by 1.06...1.1 %.

In this case, the mass fraction of protein in kefir with Elamine (Samples 5 and 6) exceeds the same parameter of the product made while using SMP (Sample 2) by 0.39...0.41.

Moreover, Table 3 shows that the mass fraction of fat in kefir with the iodine-containing additive Elamine in an amount of 0.10...0.15 mass % (Samples 5–7) exceeds the same parameter in kefir made by the traditional method of production with SMP (Sample 2) by 1.06...1.1 %. In this case, the mass fraction of protein in kefir with Elamine (Samples 5 and 6) exceeds the same parameter if the product is made while using skimmed milk powder (Sample 2) by 0.39...0.41 %.

Table 3

The physical and chemical properties of kefir produced by the traditional and the proposed methods

Parameters	By the traditional method		By the proposed method				
	Kefir	Kefir with SMP	with the iodine-containing supplement Elamine in the amount, mass %, or at a rate of g/1 liter (L) of milk				
			2.0 mass % 2 g per 1 L	0.05 mass % 0.5 g per 1 L	0.075 mass % 0.75 g per 1 L	0.1 mass % 1.00 g per 1 L	0.15 mass % 1.50 g per 1 L
	Sample1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
m/m of fat, %	3.20	3.28	4.18	4.20	4.34	4.38	4.38
m/m of protein, %	2.85	2.91	2.93	2.94	3.30	3.32	3.32
Acidity, pH units	4.55	4.65	4.67	4.56	4.54	4.53	4.50

Note: * – SMP stands for skimmed milk powder; m/m stands for mass fraction

A further increase of the Elamine concentrate content in an amount of more than 0.15 mass % in the process of producing kefir does not increase the mass fractions of fat or protein.

Smaller amounts of Elamine in the milk formula are inappropriate.

If the concentration of Elamine in kefir is reduced to less than 0.10 mass %, the mass fractions of fat and protein in the finished product decrease.

Thus, Table 3 shows that the rational concentration of the iodine-containing supplement Elamine added to a goat milk mixture in the production of kefir is 0.10...0.15 mass %.

The physicochemical properties of kefir with Elamine as to the mass fractions of fat and protein indicate its higher nutritional value in comparison with similar data on the product made with SMP by the traditional method.

The nutritional value of the experimental batches of kefir that is made from goat milk is also improved with its higher contents of essential fatty and amino acids by using the Elamine concentrate as a food additive.

The data on the biochemical composition of kefir as to the contents of total amino acids and fatty acids, including essential ones, and as to the traditional and the proposed methods of production are shown in Fig. 1–4.

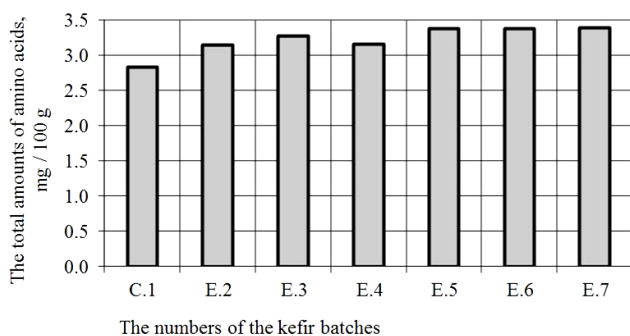


Fig. 1. The total amounts of amino acids in the control and experimental batches of kefir

The data in Fig. 1–4 show that adding the protein and carbohydrate supplement of SMP to the milk mixture does not increase the content of essential fatty acids in kefir.

In experimental batch 2 with the SMP supplement in an amount of 2 mass %, the amounts of essential fatty acids such as linoleic, linolenic, and arachidonic increased from 0.09 % to 0.10 %, compared to the same properties of control batch 1 of kefir.

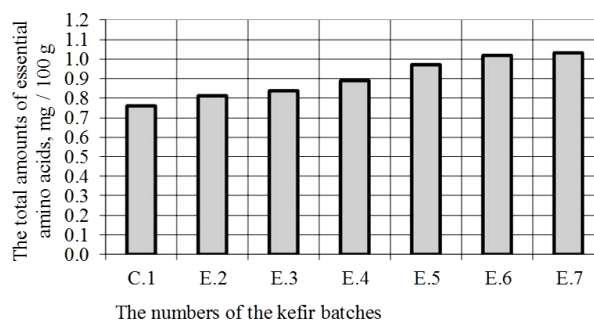


Fig. 2. The total amounts of essential amino acids in the control and experimental batches of kefir

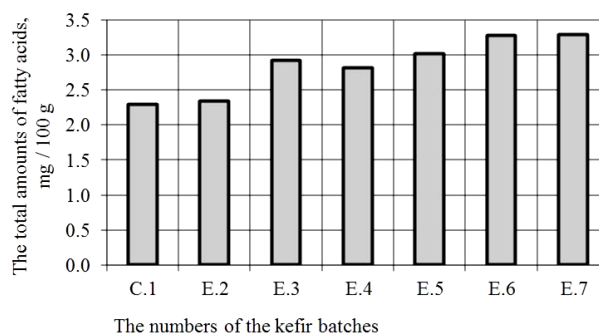


Fig. 3. The total amounts of fatty acids in the control and experimental batches of kefir

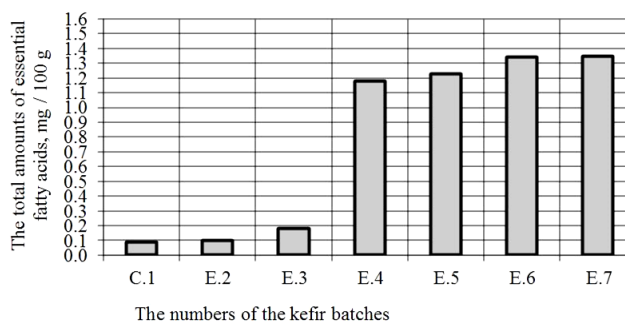


Fig. 4. The total amounts of essential fatty acids in the control and experimental batches of kefir

Using the Elamine concentrate in an amount of 0.10...0.15 mass % helped increase the amount of the aforementioned essential fatty acids from 0.09...0.10 mass % to 1.23...1.34 mass %.

In the experimental batches of kefir, the amounts of amino acids such as valine, methionine, isoleucine, leucine, and phenylalanine increased from 0.76...0.81 mass % to 0.97...1.02 mass %, compared to the same properties in the control. It is by 20...22 % more than in the control sample.

Table 4 shows data that confirm the stimulatory effect of the iodine-containing concentrate supplement Elamine on the growth and development of the microflora of bacterial cultures during fermentation of a milk mixture.

Table 4

The microbiological parameters of kefir supplementation and the duration of clot formation in hours

No.	The name of the product and the number of the batch	The names of the parameters		Clot formation, hours
		The amount of lactic acid bacteria, CFU in 1 cm ³ , not less than	The amount of yeast, not less than	
1	Kefir (supplement-free). Control sample 1	1.0×10 ⁷	1.0×10 ³	8
2	Kefir (with 2.0 mass % of skimmed milk powder). Experimental sample 2	1.0×10 ⁷	1.0×10 ³	8
3	Kefir (with 0.05 mass % of Elamine). Experimental sample 3	1.5×10 ⁷	1.20×10 ³	8
4	Kefir (with 0.75 mass % of Elamine). Experimental sample 4	2.0×10 ⁷	1.30×10 ³	7
5	Kefir (with 0.10 mass % of Elamine). Experimental sample 5	2.2×10 ⁷	1.50×10 ³	6
6	Kefir (with 0.15 mass % of Elamine). Experimental sample 6	2.5×10 ⁷	1.54×10 ³	6
7	Kefir (with 0.16 mass % of Elamine). Experimental sample 7	2.5×10 ⁷	1.55×10 ³	6

Table 4 shows that adding the iodine-containing supplement Elamine to the milk mixture in rational doses (0.10...0.15 mass %) in experimental batches of kefir 5 and 6 increased the amount of lactic acid bacteria, which are beneficial for the human body, 2.2...2.5 times in comparison with the parameters of control batch of kefir 1 and experimental batch 2 (without the use of food additives and with the use of the protein-carbohydrate supplement such as SMP) or from 1.0×10⁷ CFU/cm³ (control batch 1 and experimental batch 2) to 2.2×10⁷ CFU/cm³ (experimental batches 5 and 6).

Compared to the control batch, the amount of yeast in the batches of kefir with the iodine-containing supplement Elamine also increased 1.5 times when the supplement was in the rational dose, or in an amount from 1.0×10³ CFU/cm³ to 1.54×10³ CFU/cm³.

The tests showed that the obtained batches of goat milk kefir contained neither bacteria *E. coli* nor pathogenic microflora.

The data of Table 4 show that the increased amount of lactic acid bacteria and the slightly higher content of yeast in the kefir that was obtained by the proposed advanced technology could intensify the process of lactic fermentation (lactose). This reduced the duration of producing the experimental batches of the product by 2 hours (or 25 %) when the experimental samples were 5, 6, and 7, compared to the same property in control batch of kefir 1 and in two experimental batches, 2 and 3, respectively.

The appearance of the device to determine the amino acid composition of kefir is shown in Fig. 5.



Fig. 5. The view of the device to determine the amino acid composition of the control and experimental batches of kefir

Fig. 6 shows the appearance of the device to determine the fatty acid composition of the control and experimental batches of kefir.



Fig. 6. The view of the device to determine the fatty acid composition of kefir

Research on any food is a difficult analytical task. The problem can be solved by an instrumental method to develop an optimal technology for processing raw materials to the maximum benefit and to ensure the best production rates for high quality products.

6. Discussion of the research results about the impact of the iodine-containing supplement on increasing the coagulation density of kefir and on increasing its contents of essential amino acids and fatty acids

Physicochemical and biochemical tests were performed to determine the applicability of the iodine-containing supplement Elamine for enhancing the experimental batch of goat milk kefir in macro and micro elements, including organic iodine, amino and fatty acids (Table 1, 2).

It has been determined that Elamine contains (Table 1) calcium, phosphorus, copper, manganese, iron, and iodine in the amounts of 1.293, 0.156, 0.612, 0.915, 3.42 and 554 mg/kg, respectively. This indicates that the iodine-containing additive comprises in its composition a balanced set of micro and macro elements in an organically bound form. The contents of iodine, phosphorus, calcium, and iron are higher than in other additives.

According to the FAO/WHO scale, the scores of all essential amino acids (Table 2) of the iodine-containing supplement Elamine (threonine, valine, methionine+cystine, isoleucine, leucine, phenylalanine+tyrosine, and tryptophan) exceed those of the ideal protein by 15.5, 19.6, 17.1, 32.5, 17.3, 176.4 and 37.0 %.

The only exception is the amino acid lysine, whose score was found to be by 28.5 % less, compared to the same property of the ideal protein. This indicates that protein of the iodine-containing supplement contains a full set of essential amino acids.

It has been empirically established (Table 3) that the rational concentration of the iodine-containing supplement Elamine, which is added to the milk mixture in the production of goat milk kefir, is 0.10...0.15 mass %.

Fig. 1–4 clearly show that adding Elamine to the milk mixture increased the contents of essential amino acids and fatty acids in the experimental batches of kefir.

Adding the iodine-containing supplement Elamine to the milk mixture (Table 4) in rational doses (0.10...0.15 mass %) in experimental batches of kefir 5 and 6 increased the amount of lactic acid bacteria, which are beneficial for the human body, 2.2...2.5 times in comparison with the parameters of control batch of kefir 1 and experimental batch 2. The amount of lactic acid bacteria in samples 1 and 2 (without the use of food additives and with the use of the protein-carbohydrate supplement such as SMP) was 1.0×10^7 CFU/cm³ in each; the amount of yeast was 1.0×10^3 CFU/cm³ in each sample. A dense clot was formed in 8 hours.

Under the effect of the rational concentration of the iodine-containing supplement, the amount of lactic acid bacteria in experimental batches 5 and 6 increased to 2.2×10^7 CFU/cm³.

The amount of yeast in the experimental batches of kefir increased slightly – by 0.54 CFU/g, compared to the same property in the control batch of the product.

A dense clot in the experimental batches of kefir was formed by 2 hours earlier than in the control batch of the product, i. e. in 6 hours.

The tests have shown that the obtained batches of goat milk kefir do not contain *E. coli* and pathogenic microflora.

This allows us to recommend the product for use by dairy enterprises of Ukraine in the production process.

The cost-effective advanced technology of producing high-quality kefir from goat milk should be implemented in the technological process with regard to the following:

a) the use of the industrially-produced iodine-containing supplement Elamine, which is made at the plant Lactic Acid in Kyiv. Taken in the rational concentrations, which we have determined (0.10...0.15 mass %), this additive helps obtain a milk-protein clot of uniform color and high density without any taste of over-pasteurization, compared with similar properties in the control sample;

b) the process of clot formation is intensified in kefir that is made of milk enriched by Elamine. This reduces the coagulation time by 2 hours compared to the same period in the control batch;

c) the dairy product can be obtained from goat milk, which has a high content of beneficial microflora.

7. Conclusion

1. The contents of iodine, potassium, calcium, and iron in Elamine are much higher than in other food additives, including fructose and skimmed milk powder (SMP).

2. Adding the Elamine concentrate in an amount of 0.10...0.15 mass % in the process of making kefir increases the contents of essential amino acids such as valine, methionine, isoleucine, leucine, and phenylalanine from 0.76...0.81 mass % to 0.97...1.02 mass %, compared to the same properties in the control batch. It is by 20...22 % more than in the reference sample.

The use of the Elamine concentrate increases the amounts of essential fatty acids such as linoleic, linolenic, and arachidonic from 0.09...0.10 mass % to 1.23...1.34 mass %, compared with the control.

Adding the iodine-containing supplement Elamine in rational doses (0.10...0.15 mass %) to the milk mixture increases the amount of lactic acid bacteria, which are beneficial for the human body, 2.2...2.5 times in comparison with the parameters of control batch of kefir 1 and experimental batch 2 (without the use of food additives and with the use of the protein-carbohydrate supplement such as SMP), or from 1.0×10^7 CFU/cm³ (in control batch 1 and experimental batch 2) to 2.2×10^7 ... 2.5×10^7 CFU/cm³ (in experimental batches 5 and 6). It creates 2.2–2.5 times more of beneficial microflora than in the control, or reference, sample.

With the use of the iodine-containing supplement Elamine in the rational dose, the amount of yeast also slightly increases, by 0.54 CFU/g (1.0×10^3 CFU/cm³ to 1.54×10^3 CFU/cm³), compared to the same property in the control sample.

3. Under the influence of the iodine-containing additive, the coagulation time is reduced by 2 hours, and the dense clot is of uniform color and without any unnecessary milk powder conglomerates.

References

1. Yevlash, V. V. Deserty z kyslomolochnoho syru pidvyshchenoyi kharchovoyi tsinnosti [Text] / V. V. Yevlash, O. V. Nyemirich, A. V. Havrysh // Molochnoe delo. – 2012. – Issue 10. – P. 10–12.

2. Ahtyamova, D. I. Formirovanie assortimenta kislomolochnyh napitkov iz koz'ego moloka za schet primeneniya novykh biologicheskikh aktivnykh i pishchevykh dobavok [Text]: XXVI mezhdunar. nauch.-prakt. konf. / D. I. Ahtyamova, I. S. Bushueva // *Tekhnicheskie nauki – ot teorii k praktike*. – Novosibirsk, 2013. – Issue 9 (22). – P. 152–157.
3. Kokhan, S. V. Tekhnichne rehulyuvannya haluzi vyrobnytstva ta realizatsiyi kharchovoyi produktsiyi [Text] / S. V. Kokhan // *Molochnoe delo*. – 2012. – Issue 11-12. – P. 20–21.
4. Rodrigues, K. L. Antimicrobial and healing activity of kefir and kefiran extract [Text] / K. L. Rodrigues, L. R. G. Caputo, J. C. T. Carvalho, J. Evangelista, J. M. Schneedorf // *International Journal of Antimicrobial Agents*. – 2005. – Vol. 25, Issue 5. – P. 404–408. doi: 10.1016/j.ijantimicag.2004.09.020
5. Kubo, M. Pharmacological Study on Kefir-A Fermented Milk Product in Caucasus.I. On Antitumor Activity (1) [Text] / M. Kubo, T. Odani, S. Nakamura, S. Tokumaru, H. Matsuda // *Yakugaku Zasshi*. – 1992. – Vol. 112, Issue 7. – P. 489–495. doi: 10.1248/yakushi1947.112.7_489
6. Shydlovs'kyy, V. O. Diahnostyka ta likuvannya vuzlovoho zoba v yododefitsytnomu rehioni. Pohlyad na problemu [Text] / V. O. Shydlovs'kyy, O. V. Shydlovs'kyy // *Bukovyns'kyy medychnyy visnyk*. – 2004. – Issue 3-4. – P. 114–118.
7. Nazarov, V. P. Ispol'zovanie koncentrata «Elamina» iz morskoy vodorosli laminarii dlya minimizatsii deystviya radiatsii i yodnoy nedostatochnosti [Text] / V. P. Nazarov, L. P. Derevyanko // *Naukovi pratsi*. – 2009. – Vol. 116, Issue 103. – P. 57–63.
8. Shamanova, I. N. Razrabotka molochnogo produkta iz koz'ego moloka [Text] / I. N. Shamanova, S. Yu. Kozyreva // *Materialy konferentsii Saratovskogo GAU*. – Saratov, 2007. – P. 143–144.
9. Romanchenko, S. V. Regulirovanie konsistentsii kislomolochnykh sgustkov iz koz'ego moloka [Text]: 1 Vseukr. prakt. konf. / S. V. Romanchenko, T. N. Ryzhkova // *Pytannya tekhnolohiy ta hihiyeny kharchuvannya*. – Donetsk, 2009. – P. 63.
10. Nadtochiy, L. A. Vitaminnyy sostav i biologicheskaya cennost' altays'kogo kislomolochnogo napitka chegen [Text] / L. A. Nadtochiy, T. P. Arsen'eva, L. Ch. Buchkachakova // *Nachnyy zhurnal NIU ITMO. Ser.: Processy i apparaty pishchevykh proizvodstv*. – 2014. – Issue 4.
11. Ahtyamova, D. I. Sovershenstvovanie tekhnolohiy proizvodstva kislomolochnogo napitka za schet primeneniya biologicheskikh aktivnykh dobavok [Text] / D. I. Ahtyamova, I. S. Bushueva // *Universum: tekhnicheskie nauki*. – 2014. – Issue 1 (2).
12. Diduh, N. A. Obosnovanie sootnosheniya korov'ego i koz'ego moloka dlya proizvodstva kefira detskogo pitaniya [Text] / N. A. Diduh, S. V. Romanchenko // *Naukovi pratsi Odes'koyi natsional'noyi akademiyi kharchovykh tekhnolohiy*. – 2010. – Vol. 2, Issue 38. – P. 244–250.