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IDENTIFYING OF THE EFFECT OF THE COMBINED EXTRACT ON THE QUALITY INDICATORS OF A FERMENTED MILK PRODUCT FROM RECONSTITUTED CAMEL MILK

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The objects of the study are a fermented milk product made on the basis of reconstituted camel milk, and a fermented milk product made on the basis of reconstituted camel milk, enriched with a combined extract. The manufactured product must satisfy the body's needs for vitamins and minerals necessary for the normal development of the body. However, the nutritional composition of fermented milk drinks prepared from reconstituted camel milk depends on the choice of plant material for the added extract. The influence of the combined extract on the quality indicators of fermented milk product was studied. Under the influence of the combined extract, the protein content in the experimental sample of the fermented milk product increases by 3.96 %, and the fat content by 10.0 % compared to the fermented milk product without the addition of the combined extract. Analysis of the chemical composition and nutritional value of the developed fermented milk drink shows that it contains (in mg/100 g) minerals that were absent in the undiluted drink: magnesium – 1.12; copper – 0.044; vitamins: pantothenic acid – 0.437; nicotinic acid – 0.203; riboflavin – 0.033; vitamin E – 2.16. In addition, it has an increased content of potassium, zinc, sodium, iron, calcium; vitamins B1, B6, C, A; as well as the content of flavonoids, polyphenols and catechins. This gives it certain antioxidant properties. The results obtained indicate an increase in the biological value and additional functional properties of fortified reconstituted camel milk. It has been established that the enrichment of reconstituted milk with a combined extract makes it possible to create a product that contributes to the organization of adequate nutrition for people and will be in demand in the food market

Key words: reconstituted camel milk, combined extract, amino acids, minerals, vitamins, antioxidants

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1. Introduction

Camel milk is becoming an increasingly interesting product in the world not only because of its good nutritional properties, but also because of interesting and delicious products [1].

In the food industry of the Republic of Kazakhstan, related to the processing of agricultural raw materials, one of the most important and popular food products are camel milk and fermented milk products produced from it. In addition, they play an important role in solving the problem of providing the human body with the most valuable substances of natural origin. In this regard, camel milk is a very promising raw material for the development and production of new types of products based on camel milk.

The growing interest in camel milk in the world is largely due to its positive impact on human health, gives rise to the urgency and necessity of scientific research and development aimed at the development of new food products.

The prospects of camel milk research as a raw material for the development and production of new products are confirmed by numerous studies. Camel milk, which is produced annually around 5.3 million tons worldwide, is the optimal raw material for creating functional nutrition products in its full composition [2].

The author of this work substantiates the demand for camel milk as a food product in the countries of the Middle East, Asia and Africa based on the analysis of the content of useful substances in it. It is rich in antioxidants that help prevent serious diseases such as cancer, diabetes and heart disease. Camel milk is also rich in vitamins and minerals: A, B, C, D, E, C, calcium, copper, magnesium, potassium.

Due to its unique nutritional properties and digestibility compared to cow's milk, camel milk has been used for the production of several products [3]. Dairy products developed from camel milk may have the opportunity to progress into the dairy market due to the potential therapeutic properties of camel milk, such as tuberculosis, asthma, diabetes, jaundice, dropsy and visceral leishmaniasis [4].

The composition of milk is important because it determines its nutritional value and technological properties when processing milk into value-added dairy products [5].

However, the shelf life of raw camel milk is 8–9 hours at 37 °C and more than a week at 4–6 °C. For effective preservation of raw camel milk, the lactoperoxidase system in fresh camel milk can be activated at the hour of milking using various levels of thiocyanate and hydrogen peroxide for up to 18–20 hours at 37 °C [6]. The production of dry camel milk will contribute to the commercialization of camel milk in the regions of excess production. This will facilitate the export of camel milk in powder form, ensure a stable product during storage and allow the distribution of camel milk to areas where camels are not found. The availability of camel milk powder will also facilitate the development of other food products (such as yogurt, cheese, confectionery, etc.) from camel milk [7].

In addition, food fortification is one of the well-known public health measures and one of the most effective methods of preventing nutrient deficiency [8].

Therefore, research on the development and enrichment of camel milk products is relevant.

2. Literature review and problem statement

A wide range of studies on the development of fermented milk products from camel milk has been established [9, 10].

It is shown that, based on an analysis of world experience in the field of achievements in the processing of camel milk, predominantly raw camel milk was used for the production of fermented milk products.

Camel milk is a high-quality milk with high nutritional value and health benefits. Camel milk contains a variety of nutrients such as fat, protein, vitamins, lactose, etc. The milk production and quality of camels is influenced by their size, age and feeding conditions [11].

However, the global supply of camel milk is very limited because camels are usually raised in countries with arid conditions, such as deserts. One of the best approaches to extend the shelf life, reduce transportation costs and expand the use of camel milk is to produce camel milk powder that can be distributed throughout the world [12].

The studies that can be found in the literature are focused on camel milk powder, and these studies were limited to determining the effect of the drying process on the nutritional properties of camel milk powder [13].

But they are still unresolved questions related to the production of products from reconstituted camel milk. Regardless of the type of drying, changes in the chemical composition and nutrients of camel milk are inevitable.

An option to overcome the relevant difficulties can be to enrich the composition of reconstituted camel milk with plant components or plant extract.

This approach was used in the selection of plant raw materials for the production of a combined extract for enrichment.

However, when organizing the production of such useful substances, the main problem is the correct choice of food ingredients. The solution to this problem can be provided by world experience in this field, which shows that in order to meet the needs of the human body with biologically active substances, the emphasis is on plant raw materials.

The prospects of using grape seeds to enrich reconstituted camel milk in the development and production of new enriched products are justified by the fact that they are a source of unique chemical compounds. Grape seeds contain polyphenols, flavonoids, beta-sitosterol, stigmasterol, carotenoids, complexes of fruit and phenolic acids, as well as a complex of vitamins and trace elements [14].

In addition, in many food industries, they are secondary raw materials obtained from grape processing waste. Therefore, their application will also contribute to the creation of low-waste technology in the production of food products.

The prospects of flax seeds for enriching camel milk can also be justified by the richness of their chemical composition.

Flaxseed (Linumusitatissimum) is an abundant prominent source of α-linolenic acid and lignans in the functional food. Significant evidence indicated that flaxseed possesses various bioactivities such as anticancer activity, anti-obesity activity, anti-diabetic activity, and so on [15].

All the richness of flax seeds allows them to be used as a food additive to increase the nutritional value of various types of dairy products.

However, direct use of both grape seeds and flax seeds to enrich the composition of camel milk and fermented milk products produced from it is impossible. Therefore, it is necessary to choose a method for extracting the necessary nutrients from them. To isolate these substances from the seeds in question, it is of interest to choose the extraction method [16].

With the use of low-frequency vacuum-ultrasonic technology, a combined extract of plant raw materials – grape seeds and flax seeds – enriches the nutritional value of reconstituted camel milk [17].

The results of these studies indicate the need to use plant extract to fortify reconstituted camel milk. All this suggests the advisability of conducting a study of the influence of the combined extract on the quality indicators of the fermented milk product. All this allows to assert that it is advisable to conduct a study devoted to the study of physicochemical parameters, amino acids, fatty acids, vitamins, mineral and antioxidant composition of fermented milk products enriched with plant extract.

3. The aim and objectives of the study

The aim of the study is to assessment of quality indicators of a fermented milk product from reconstituted camel milk when influenced by combined extract.

To achieve this aim, the following objectives are accomplished:

– to conduct a physicochemical analysis of fermented milk products;

– to conduct a study of the amino acid and fatty acid composition of fermented products;

– to conduct a study of the mineral and vitamin composition of fermented milk products;

– to conduct a study of the antioxidant composition of fermented milk products.

4. Materials and methods

The objects of the study are a fermented milk product produced on the basis of reconstituted camel milk and a fermented milk product produced on the basis of reconstituted camel milk enriched with a combined extract. The main hypothesis of the study is that the addition of a combined extract in an amount of 7 % will make it possible to develop a full-fledged product from the point of view of functional nutrition.

The physicochemical parameters of the developed fermented milk drink were studied in compliance with the following standards and standard measuring and analytical instruments:

– milk density was determined using a hydrometer GOST 18481-81 (1981);

– the mass fraction of fat was determined according to GOST 5867-90 (1991);

– the mass fraction of protein was determined according to GOST 23327-98 (2000);

– the solubility index, cm 3 was determined according to GOST R ISO 8156-2010 (2010);

– the mass fraction of ash was determined according to GOST 54668-2011 (2011);

– the mass fraction of moisture was determined according to GOST ISO 5537-2015 (2015);

– titrated acidity was determined according to GOST ISO-6091-2015 (2015);

– the pH of active acidity was determined using the ionomer "SCHOTT Instrument" Lab 850 (Germany);

– the mineral content was studied by atomic absorption spectrometry (AAS);

– the quantitative content of amino acids was determined using high-performance liquid chromatography (HPLC Waters, Alliance e2695, USA) based on internal standards and single-point calibration;

– the composition of fatty acids was determined by gas chromatography on a Crystal-4000 gas-liquid chromatography with a flame ionization detector and the NetChrom program during transesterification of milk fat with sodium methylate in methanol. The separation of methyl esters was carried out on a capillary column with a length of 30 m and an inner diameter of 0.25 mm, carrier gas – hydrogen was passed at a rate of 40 ml/h. Separation was carried out on the polar stationary phase of SUPELCOQAX-10 by increasing the temperature from 60 °C to 180 °C at a rate of 20 °C per minute, the maximum temperature in the column is 230 °C;

– the content of antioxidant substances was studied by spectrophotometric method.

Statistical processing of all data obtained was carried out using the Statistics program version 13 and in the Microsoft Excel package program.

5. Results of assessing the quality indicators of a fermented milk product

5. 1. Results of physicochemical analysis of fermented milk products

The physicochemical parameters of the developed fermented milk drink in comparison with a drink without the introduction of a combined concentrator are presented in Table 1.

Table 1

Physicochemical parameters of the developed fermented milk drink in comparison with a drink without the introduction of a combined concentrator

Quality шndicators	Content of fermented milk drink	
	Without adding a combined extract	With the addition of a combined extract
Proteins, %	3.22	3.45
Fats, %	4.0	4.4
Carbohydrates, %	4.8	4.9
Ash, %	0.62	0.81
Acidity, °T	18.0	21.0
pH	6.37	6.15
Energy value, kcal	68.08	73

As can be seen from the data in Table 1, it shows that due to the enrichment of the composition of the reconstituted camel milk with a combined extract, the protein content in the experimental sample of the fermented milk product increases by 3.96 %, and the fat content by 10.0 % compared to the fermented milk product without enrichment with a combined extract.

5. 2. Results of a study of the amino acid and fatty acid composition of fermented milk products

The amino acid composition of the control and fermented milk product from reconstituted camel milk enriched with a combined extract was studied using high-performance liquid chromatography (HPLC Waters, Alliance e2695, USA). Chromatograms are shown in Fig. 1, 2. In addition, the chromatogram processing data are presented in Table 2.

Table 2

Amino acid composition of the control sample and fermented milk product from reconstituted camel milk enriched with a combined extract

Amino Acids	Control sample		With the addition of a combined extract	
	Quantity, mg/l	Weight, %	Quantity, mg/l	Weight, %
Essential amino acids				
Valine	18.0	0.106±0.042	35.0	0.140±0.056
Leucine+ +Isoleucine	24.0	0.141±0.037	44.0	0.176±0.046
Threonine	13.0	0.076±0.031	26.0	0.104±0.042
Methionine	8.8	0.052±0.018	11.0	0.044±0.015
Lysine	12.0	0.070±0.024	20.0	0.080±0.027
Phenylalanine	21.0	0.123±0.037	30.0	0.120±0.036
Partially replaceable Amino Acids				
Histidine	12.0	0.070±0.035	19.0	0.076±0.038
Arginine	17.0	0.100±0.040	57	0.228±0.091
Nonessential amino acids				
Tyrosine	11.0	0.065±0.019	17.0	0.068±0.020
Proline	53.0	0.311±0.081	72.0	0.228±0.075
Serine	22.0	0.129±0.034	35.0	0.140±0.036
Alanine	17.0	0.100±0.026	38.0	0.152±0.039
Glycine	18.0	0.106±0.036	31.0	0.124±0.042

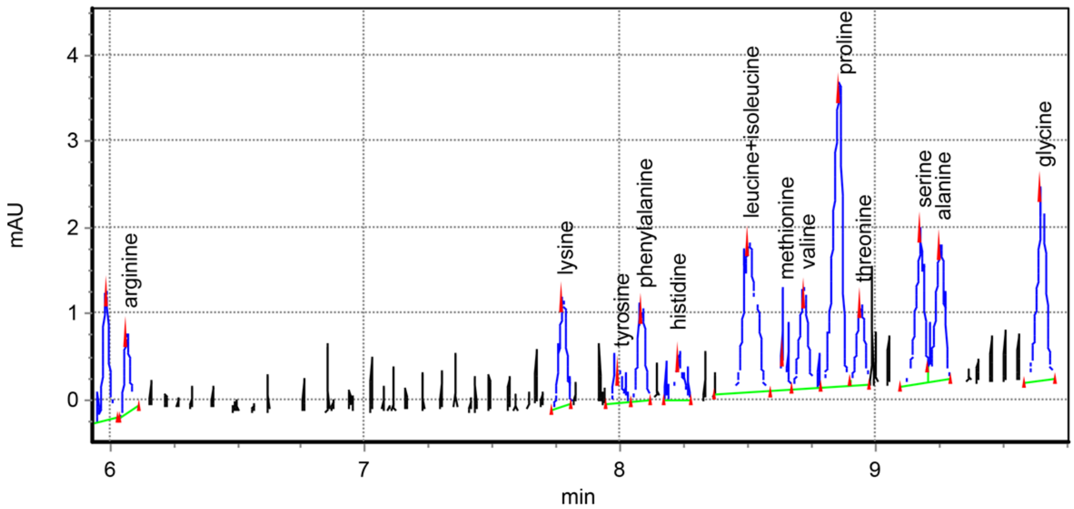

Fig. 1. Chromatogram of amino acid composition in a control sample of a fermented milk product

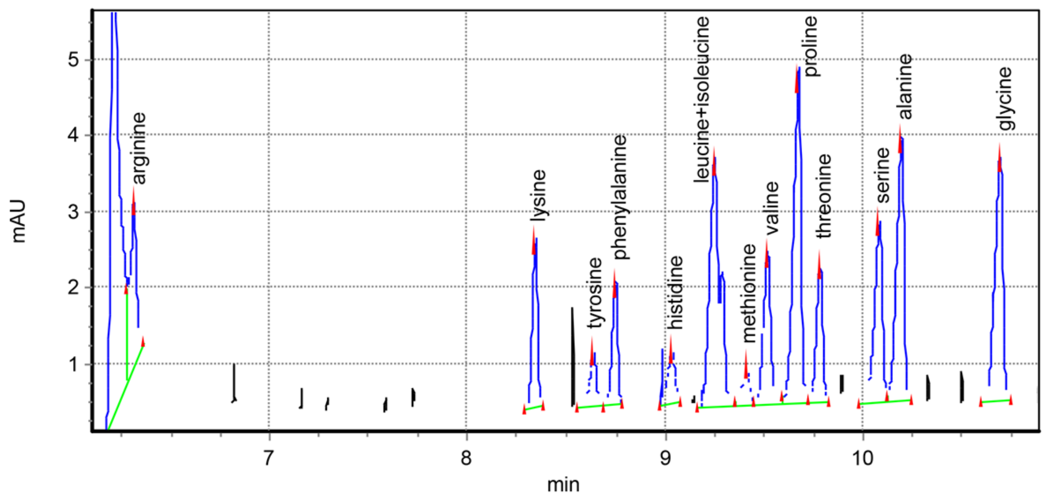

Fig. 2. Chromatogram of amino acid composition of fermented milk product from reconstituted camel milk enriched with a combined extract

As the analysis of the data in Table 2 shows, the composition of the fermented milk product with the addition of a combined extract contains the amino acid tyrosine by 54.5 %, proline by 35.85 %, serine by 59.10 % and alanine by 2.23 times, and the amino acid glycine 72.0 % more than in the control sample.

A comparative analysis of the composition of essential amino acids shows that the content of valine in the composition of the prototype fermented milk product is 1.94 times greater than the control sample. The content of phenylalanine, one of the important essential amino acids, in the composition of the prototype is 1.42 times higher than the control sample. In the experimental sample, the predominant essential branched chain amino acid is leucine+isoleucine, which belongs to the most important and main amino acids.

The total content of essential and non-essential amino acids in the test sample is 359 mg/g, in the control sample (217 mg/l).

The fatty acid composition of the control sample and the fermented milk product from reconstituted camel milk enriched with a combined extract was studied by gas chromatography on a gas-liquid chromatograph "Crystal-4000" with a flame ionization detector and the NetChrom program (GOST 30418-96). Chromatograms are shown in Fig. 3, 4. In addition, the processed chromatogram data are presented in Table 3.

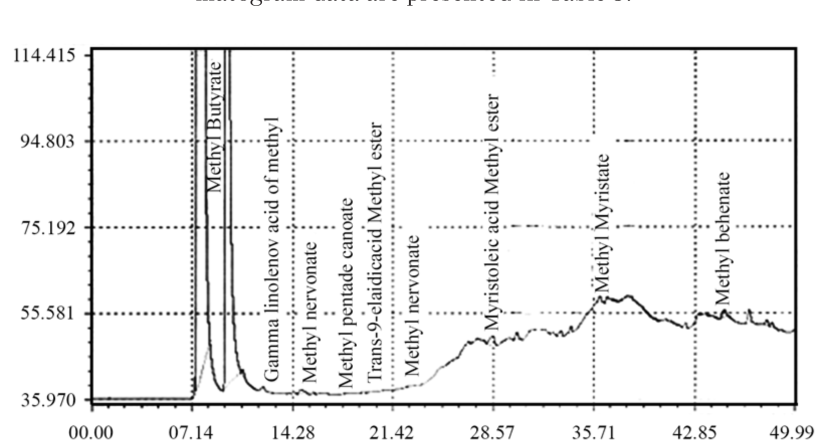

Fig. 3. Chromatogram of the composition of fatty acids in a control sample of a fermented milk product

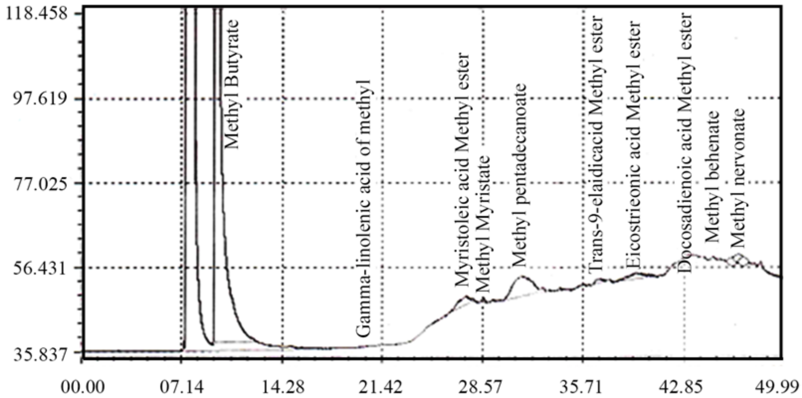

Fig. 4. Chromatogram of the composition of fatty acids in a fermented milk product from reconstituted camel milk enriched with a combined extract

Table 3

Composition of fatty acids of the control sample and fermented milk product from reconstituted camel milk enriched with a combined extract

Fatty acids	Common name	CD (Carbon atom: double bond)	Control sample	With the addition of a combined extract
			Weight, %	Weight, %
Methyl Butyrate	Butyric acid	C_4:0	94.30	80.62
Myristoleic acid Methyl ester	Myristoleic acid	$C_{15}H_{28}O_2$	0.20	1.26
Methyl Myristate	Myristic acid	$C_{15}H_{30}O_2$	2.41	0.71
Methyl pentadecanoate	Pentadecanoic acid	$C_{16}H_{32}O_2$	0.21	9.55
Gamma-linolenic acid of methyl	Gamma-linolenic acid	$C_{19}H_{32}O_2$	0.19	0.15
Trans-9-elaidic acid Methyl ester	Elaidic acid	$C_{19}H_{36}O_2$	0.10	0.65
Eicosatrieonic acid Methyl ester	Digomo-gamma-linolenic acid (Omega-6)	$C_{20}H_{34}O_2$	–	1.95
Docosadienoic acid methyl ester	Arachidonicac id(Omega-3)	$C_{23}H_{42}O_2$	0.06	4.19
Methylbehenate	Behenic acid	$C_{23}H_{46}O_2$	1.20	0.61
Methylnervonate	Nervonic acid	$C_{25}H_{48}O_2$	0.25	0.30

An analysis of the data in Table 3 shows that 10 types of fatty acids were detected. A comparative analysis of the fatty acid content of the control and experimental samples of the fermented milk product shows that when the composition of the prototype is enriched with a combined extract, the content of saturated fatty acids decreases.

5. 3. Results of a study of the mineral and vitamin composition of fermented milk products

The composition of water-soluble vitamins of group B of the control sample and a fermented milk product from reconstituted camel milk enriched with a combined extract was studied according to the method M 04-41-2005 (Certificate of certification of measurement methodology No. 224.04.17.035/2006. Basically, the method consists in isolating thiamine from the sample of the analyzed product with a solution of sulfuric acid, oxidizing it with a solution of potassium iron cyanide into thiochrome, extracting the oxidized form from the aqueous phase with isobutyl alcohol, measuring the intensity of fluorescence (by capillary electrophoresis).

To determine vitamin A, GOST R54635-2011 was used (Methodology for determining the mass fraction of vitamin A in the form of retinol, retinol acetate, retinol palmitate by high-performance liquid chromatography. Recent studies show that the vitamin content in camel milk depends on the season of the year, breed, age, animal conditions and the chosen drying method [18] in Fig. 5, 6. In addition, the processed chromatogram data are presented in Table 4.

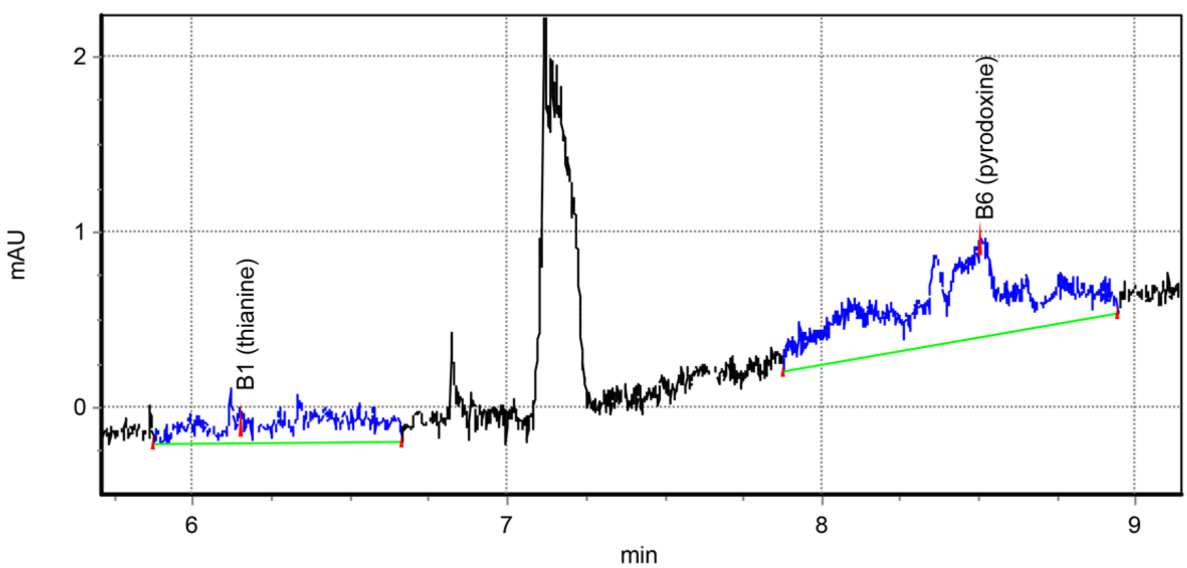

Fig. 5. Chromatogram of the vitamin composition of the control sample of the fermented milk product

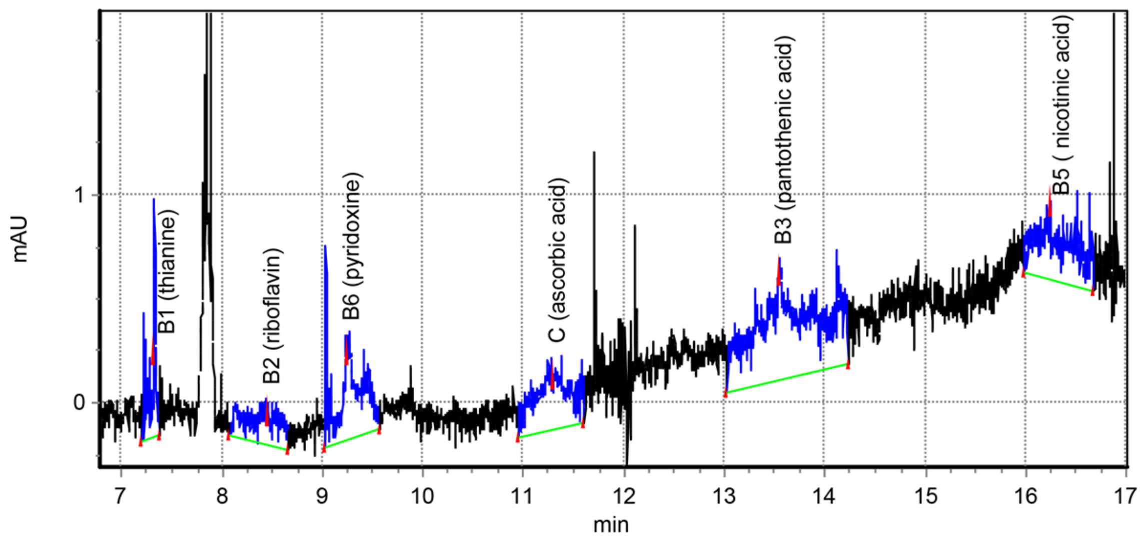

Fig. 6. Chromatogram of vitamin composition of fermented milk product from reconstituted camel milk enriched with a combined extract

Table 4

Vitamin content

Vitamins	Control sample	With the addition of a combined extract
	Weight, **mg**/100g.	Weight, **mg**/100g.
A (retinol)	0.036	0.042
B1 (thiamine)	0.059±0.012	0.094±0.005
B2 (riboflavin)	–	0.033±0.014
B6 (pyridoxine)	0.092±0.018	0.165±0.008
C (ascorbic acid)	1.076±0.011	1.466±0.0121
B3(pantothenic acid)	–	0.437±0.087
B5(nicotinic acid)	–	0.203±0.007
E (tocopherol)	–	2.16

The analysis of Table 4 shows that the content of water-soluble vitamins in the composition of the control and prototype shows that as a result of the enrichment of the composition of the fermented milk product, the prototype was additionally enriched with the following water-soluble vitamins riboflavin (B2), vitamin PP, (B3) and pantothenic acid (B5), as well as fat-soluble vitamin tocopherol (E).

The mineral content was studied by atomic absorption spectrometry (AAS). The results of the study are presented in Table 5.

Table 5

Mineral content

Minerals	Control sample	With the addition of a combined extract
	Weight, mg/100g	Weight, mg/100g
Potassium	162.47±0.65	163.74±0.54
Calcium	138.53±0.45	139.18±0.37
Magnesium	–	1.12±0.002
Sodium	58.63±0.12	60.37±0.13
Iron	0.12±0.002	0.13±0.002
Copper	–	0.044±0.0002
Zinc	0.37±0.002	0.39±0.002

The data in Table 5 show that the content of macronutrients was higher than the control. For example, if the calcium content in the test sample is 0.47 %, then the potassium content is 0.78 % higher than in the control sample.

The study of the content of trace elements shows that the iron content in the experimental sample of the fermented milk product is 7.69 %, and the zinc content is 5.13 % higher than in the control sample. As a result of enrichment with a combined extract, the trace elements magnesium and copper were found in the composition of the prototype of the fermented milk product.

5. 4. Results of a study of the antioxidant composition of fermented milk products

The content of antioxidant substances was studied by spectrophotometric method. The results of the study are presented in Table 6.

Table 6

Content of antioxidant substances

Antioxidant substances	Control sample	With the addition of a combined extract
Polyphenols, %	0.38±0.001	0.43±0.001
Flavonoids, %	0.152±0.002	0.168±0.002
Catechin, mg/g	0.094±0.001	0.104±0.001

The data in Table 6 show an increase in the content of antioxidant substances in a fermented milk drink with the addition of a combined extract: flavonoids by 10.56 %, catechin by 10.64 % and polyphenols by 13.16 %.

6. Discussion of the results of a study of the effect of the extract on the quality of fermented milk product

To provide additional functionality, reconstituted camel milk must be enriched with biologically active components in the form of an extract. Due to the enrichment of the composition of the reconstituted camel milk with a combined extract, the content of protein, fat and carbohydrates in the experimental sample of the fermented milk product increases in comparison with the fermented milk product without enrichment with a combined extract (Table 1).

In a fermented milk product with the addition of a combined extract of amino acids: tyrosine – 54.5 **%**, proline– 35.85 **%**, serine – 59.10 **%** and alanine – 2.23 times more glycine amino acids – 72.0 **%** more than in the control sample (Fig. 1, 2). This significantly increases its biological value. Tyrosine is a precursor to the hormones dopamine, adrenaline, norepinephrine and thyroxine. Improves attention, memory, concentration, supports the nervous system. Alanine strengthens the immune system and is involved in the metabolism of sugars and organic acids in the human body. Serine plays an important role in the metabolic processes of the body, provides the catalytic effect of enzymes, and is part of many proteins of plant origin.

As a result of enriching the composition of a prototype fermented milk product with a combined extract, the content of unsaturated fatty acids increases. For example, if the content of unsaturated fatty acids in the control sample is 0.25 mg/l, then in the test sample its content is 4.39 mg/l, i.e. in the composition of the test sample, the content of unsaturated fatty acids increased more than 17.56 **time**s (Table 3).Polyunsaturated fatty acids play a preventive and therapeutic role in the body.

Based on the content of water-soluble vitamins in the control and prototype, it is clear that as a result of enriching the composition of the fermented milk product, the prototype was additionally enriched with the following water-soluble vitamins riboflavin (0.033±0,014): vitamin PP, (0.437±0.087) and pantothenic acid (0.203±0.007), as well as the fat-soluble vitamin tocopherol (2.16) (Table 4). As a result of enrichment with the combined extract, the microelements magnesium and copper were found in the experimental sample of the fermented milk product (Table 5). The content of antioxidant substances in the fermented milk drink has increased.

The limitations of this study include the lack of regulatory technological documentation for the production of fermented milk products. The disadvantages of this study include the fact that camel milk powder is a fairly expensive raw material. However, for this it is possible to improve the method of vacuum sublimation of camel milk. The proposed technology will significantly reduce drying costs. Further research will be aimed at determining microbiological indicators, safety indicators and shelf life of fermented milk product from reconstituted camel milk.

7. Conclusions

1. Under the influence of the combined extract, the protein content in the experimental sample of the fermented milk product increases by 3.96 %, and the fat content by 10.0 % compared to the fermented milk product without the addition of the combined extract.

2. It was found that when enriching the composition of reduced camel milk with a combined extract, the content of amino acids increases by 39.55 %, polyunsaturated fatty acids increases 17.56 times, and the content of saturated fatty acids decreases by 16.31 %.

3. It is proved that the enriched drink contains (in mg/100g) minerals that were absent in the unenforced drink: magnesium – 1,12; copper – 0.044; vitamins: pantothenic acid – 0.437; nicotinic acid – 0.203; riboflavin – 0.033; vitamin E – 2.16.

4. Studies have found an increase in the content of antioxidant substances in the test sample: flavonoids by 10.56 %, catechin by 10.64 % and polyphenols by 13.16 %.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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The study was performed without financial support.

Data availability

Data will be made available on reasonable request.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating this work.

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