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Identification of yeast species involved in fermentation of the Kazakh camel dairy product–shubat

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Abstract. In certain countries of the world, camel's milk is used for food on a level with cow's milk. *Shubat* is a traditional food product based on camel milk in Kazakhstan. It is a fermented milk product obtained as a result of spontaneous fermentation of camel's milk under the influence of native microflora. Received dairy product from the southern region of Kazakhstan became the object of the investigation of the microflora of the fermented milk product *shubat*. The aim of the research was to study the microflora of camel milk, which causes its spontaneous fermentation. During the experiment, the dynamics of acid accumulation by the change in active acidity (pH) and titratable acidity (°T) was studied. In addition to lactic fermentation fermented product (*shubat*), alcoholic fermentation was noted, which has given the finished product an increased acidity and a high degree of gassing. To enumerate and identify microorganisms, *shubat* was sown to the following nutrient media: MRS, Malt wort-agar medium at 36 °C and 30 °C respectively both for 3 days. We suppose that the dominant component of the *shubat's* microflora was yeasts: *Brettanomyces anomalus, Naumovozyma castellii*. Pathogenic microorganisms, such as *Salmonella, Shigella*, were not detected during the research, considering that the *shubat* is formed as a result of spontaneous fermentation and has poor hygienic characteristics in comparison with pasteurized milk. Identification of individual strains of bacteria allows us to simulate a starter microflora for the production of a safe fermented product based on camel milk on an industrial scale in Kazakhstan. The identified microflora, which causes spontaneous fermentation of camel milk and isolated strains of lactic acid bacteria, will make a significant contribution to the improvement of food safety in arid regions.

Key words: camel milk, *shubat*, spontaneously fermented dairy products, lactic acid bacteria, yeasts, *Brettanomyces anomalus*, *Naumovozyma castellii.*

INTRODUCTION

Nowadays camel's milk and products based on it are adequately consumed in food in various countries of the world (Rashid et al., 2007; Abdelgadir et al., 2008). The most popular are such products in arid and semi-arid regions, where climatic conditions are favorable for breeding camels and having a number of advantages for this type of farm animals. Historically, camel's milk is consumed as food to meet the nutrient and energy needs (Dirar, 1993; Ahmed et al., 2010).

According to several authors' researches, the composition of camel milk varies depending on its geographical origin, the physiological state of the animal, the conditions of keeping, feeding, lactation, heredity, health of camels, etc. (Shori, 2017).

The current demand for camel milk products is also due to the historically prevailing preferences of the population (Lore et al., 2005; El-Hadi Sulieman et al., 2006b; Shori, 2012; Yam et al., 2014). It is evident that camel milk and sour-milk products based on it were used to treat certain diseases (Mal et al., 2000; Yagil & Van Creveld, 2000; Mohamad et al., 2009). Many authors argue that camel milk has antimicrobial activity against pathogenic bacteria (Abbas & Mahasneh, 2014). According to the publications of the authors, it is known that camel's milk has the ability to ferment naturally to the fermented milk product, without preliminary heat treatment and without the addition of starter cultures (Wullschleger et al., 2013; Kaindi et al., 2018). The authors determined that the suppression or intensification of the microorganisms' development in dairy raw materials can be carried out, including means of ultrasonic action inside process pipelines (Suchkova et al., 2014).

It is known that the milk of farm animals is favorable environment for the growth of lactic acid bacteria and yeast (Jans et al., 2012). Among the lactic acid bacteria, probiotics are of particular importance, useful properties of them are the following: stimulating the reaction of the human immune system, preventing the development of pathogenic bacteria in the body, preventing the development of a number of diseases of the gastrointestinal tract, etc. (Borisova et al., 2008). Due to the development of fermented microflora, fermented milk drinks have a number of nutraceutical properties for the human body, in particular, they stimulate appetite, quench thirst, stimulate the release of gastric juice, enhance the peristalsis of the gastrointestinal tract, improve kidney function, have antibiotic properties, etc. (Lopatina et al., 1997; Glushanova, 2003). In addition, dairy products can be further functionalized using various biologically active substances (Zabodalova et al., 2014).

In different parts of the world, dairy products based on camel milk have unique names, for example in Sudan and Somalia, the *gariss* product is very popular, it is also known as 'hameedh' or 'humadah' (El-Hadi Sulieman et al., 2006b; Shori, 2012). In South Africa and Kenya, a similar product was named '*suusac*' (Lore et al., 2005). In Turkey, fermented milk drink is known as '*chal*' and otherwise referred to as a '*Turkic drink*' (Yam et al., 2014). The product '*shubat*' is widely consumed in Kazakhstan (Rahman et al., 2009b; Akhmetsadykova et al., 2014).

Traditionally, all these fermented milk products are produced by spontaneous fermentation as a result of the development of native microflora inherent to camel milk: lactic acid bacteria and yeast (Holzapfel, 2002; Lore et al., 2005). Lactic acid bacteria provide lactic fermentation of the milk base, resulting in the accumulation of lactic acid in the product. Yeast, in turn, causes alcohol fermentation in the fermented milk product,

which leads to the accumulation of a sufficiently high amount of carbon dioxide and ethanol (Madadlou et al., 2005; Oleshkevich et al., 2013). According to organoleptic indices, fermented milk products based on camel milk have a homogeneous, foaming, viscous consistency, characteristic white color peculiar to camel's milk, a specific smell and taste (Hassan et al., 2008).

The fermented product *shubat* was made from ancient times by the Turkic people. Modern Turkic peoples are numerous, including Kazakhs. Thus, at present, the dairy product *Shubat* is rightly recognized as a Kazakh national drink (Rahman et al., 2009b; Akhmetsadykova et al., 2014). According to the traditional technology, the product is prepared at home, most often from the milk of Bactrian camels, at room temperature by spontaneous fermentation for 3–4 days. The optimal temperature of milk ripening varies from 25 to 30 °C. It can be noted that camel's milk is not fermented at a temperature below 10 °C with a fermentation time of 72 hours or more (Rashid et al., 2007). To accelerate the fermentation of the *shubat* drink, some of it is mixed with a new portion of raw camel milk, resulting in an optimization of the time factor for obtaining the finished product (Saitmuratova & Sulaimanova, 2000). As noted earlier, mixed fermentation produces lactic acid and carbon dioxide, which leads to a significant decrease in the active acidity to 3.96 pH and an increase in titrated acidity to 181 °T (Rahman et al., 2009a).

In the study of the microflora of fermented milk products based on camel milk, scientists from different countries have found that *Lactobacillus* is a significant quantity, which is an acid-forming component, and to a lesser extent *Entorococcus*, which promotes aromatization in the final product (Abdelgadir et al., 2001; Gonfa et al., 2001; Narvhus & Gadaga, 2003; Sulieman et al., 2006a; Omar et al., 2007). The active acid formation of the lactic acid bacteria (LAB) is considered as one of the important factors of antagonism to a pathogenic microflora (Borisova et al., 2008). It has been proven that members of the genus *Lactobacillus* stimulate the suppressed immune system and do not affect the immune system that is in a normal state (Glushanova, 2003).

In this connection, a special interest, in our opinion, is the study of the qualitative, quantitative and specific composition of the microflora of a lactic acid drink–*shubat*, which is produced in a traditional way, in particular, through spontaneous fermentation of raw camel milk. The present work is aimed at studying the microflora of the national Kazakh *shubat* product and its safety performance indicators.

MATERIALS AND METHODS

Sampling

As objects of research used: raw camel milk (sample number 1) and sour milk product based on camel milk – *shubat* – (sample number 2), obtained from the southern region of Kazakhstan. To receive reliable results of the experiment, sample No. 1 was obtained from three different camels and subjected to physicochemical and microbiological methods of analysis no later than 2 hours after its preparation. Sample No. 2 was obtained as a result of spontaneous fermentation of assembled camel milk, after it was hermetically packed in thermal containers and transported at 4 ± 2 °C for further research in the laboratory of St. Petersburg and the Leningrad Region, in particular in the ITMO University laboratory; the laboratory of genetics of plant-microbial interactions of the All-Russian Scientific Research Institute of Agricultural

Microbiology and the laboratory of the St. Petersburg branch of the Research Institute of the baking industry. During the experiment the storage temperature of sample No. 2 was maintained within 5 ± 1 °C.

All studies of sample No. 1 and sample No. 2 were obtained in triplicate.

The physico-chemical analysis of sample No. 1 included a number of studies: on the determination of titrated acidity, active acidity, protein content, fat, lactose, ash, salts, density, freezing temperature. Investigation of the physicochemical properties of sample No. 1 was carried out on an ultrasonic milk quality analyzer *Klever-2M,* (Biomer, Russian Federation). The operation principle of this analyzer is based on passing ultrasound vibrations through the sample and recording the values of output signals depending on the values of measured milk's parameters of various types of farm animals. The device was calibrated on camel milk in order to minimize measurement errors under the manufacturer documentation and methodology.

The physico-chemical analysis of sample No. 2 was carried out by determining the titratable acidity, the active acidity and the ethanol content:

Determination of active and titratable acidity

The measurement of active acidity of each samples repeated three times, each time removing the electrodes from the sample and immersing them into the sample (GOST (Russian National State Standard) 32892–2014).

The results of the measurement of active acidity in milk and dairy products were obtained by taking the arithmetic mean of the results of three parallel determinations.

The titrimetric determination of acidity of the samples were accomplished according to the method described by Nadtochii (Nadtochii & Koryagina et al., 2014).

Determination of ethanol content

A 3 mL sample was steam distillated into acidified potassium dichromate solution. Unreacted dichromate was determined by titration with ferrous ammonium sulphate solution using phenanthroline as an indicator (Bradley et al., 1992).

The antibiotics analysis of sample No. 1 and 2. The content of antibiotics such as levomycetin, tetracycline group, streptomycin, penicillin was conducted according to Methodical Guidelines '4.2.026-95 – Express method for the determination of antibiotics in food products'.

The toxic elements analysis of sample No. 1 and 2. The study on the presence of toxic elements (Pb, Cd, As, Hg) was performed according to GOST 33824-2016 Food products and food raw materials.

The content of radionuclides of sample No. 1 and 2. The content of radionuclides (Cs, Sr) was investigated in accordance with GOST 32161-2013 'Food products. Method for determination of cesium Cs-137' and GOST 32163-2013 'Food products. Method for determination of strontium content Sr-90'.

The content of pesticides of sample No. 1 and 2. The samples with pesticides were determined according to the methodological guidelines for the determination of organochlorine pesticides in water, food products, feed and tobacco products by thin-layer chromatography. The method is based on chromatography of chlorine-containing pesticides in a thin layer of aluminum oxide, silica gel or Silufo plates in various systems of mobile solvents after their extraction from the samples and purification of the extracts. The mobile solvent is n-hexane or n-hexane mixed with acetone. The sites of localization of the drugs are detected after spraying the plates with a solution of silver ammine followed by ultraviolet irradiation or after irradiating ultraviolet light with Silufol-

containing o-tolidine plates. The determination of pesticides was carried out according to Methodical Guidelines 2142-80 'Guidelines for the determination of organochlorine pesticides in water, food, feed and tobacco products by thin-layer chromatography'.

The content of aflatoxins of sample No. 1 and 2. The method is based on the extraction of aflatoxins M1 from a sample of the product, purification of the extract from interfering substances, and measuring the mass concentration of aflatoxin M using thin-layer chromatography by visually determining the amount of substance in the spot. The range of measured contents in dairy products: 0.0005–0.005 mg kg^{-1}. The content of aflatoxins was investigated in accordance with GOST 30711-2001 'Food products. Methods for detection and determination of aflatoxins B (1) and M (1)'.

Microbiological analysis of sample No. 1. Quantity of Mesophilic Aerobic and Facultative Anaerobic Microorganisms (*QMAFAnM*) and pathogenic microorganisms were determined according to the standard method GOST 10444.15-94 and GOST 31659-2012 (ISO 6579: 2002), respectively.

Microbiological analysis of sample No. 2. Lactic acid microorganisms were determined by GOST 10444.15.94, bacteria of the group of *Escherichia coli,* in particular coliforms – GOST 32901-2014, pathogenic microorganisms – GOST 31659-2012, including *Staphylococcus Aureus* – GOST 30347-2016, mold and yeast – GOST 10444.12-13.

Enumeration of microorganisms of sample No. 2. Ten (10) mL of camel milk sample were homogenized with 90 mL of saline water (8.5 g L^{-1}) to make an initial dilution (10^{-1}). The suspension was used for making suitable serial dilutions up to 10^{-8} by incorporating 1 mL into 9 mL of sterile saline water in sterile tubes. Enumeration of LAB and yeast were determined using media MRS agar and Malt wort-agar, respectively. LAB strains were incubated in MRS media at 36 °C for 3 days and yeast incubated in malt wort-agar at 30 °C for 3 days (Tezira et al., 2005; Nurgul et al., 2009). After the incubation, the Petri dishes with a number of colonies from 30 to 300 were studied using colony counter (Goryaev's chamber) with a 1 cm grid and side lighting. The colonies were counted in at least 20 squares, determining their average number by one cm^2. The result was multiplied by the surface area of the medium in the cup (Eremina & Kriger, 2005).

Preparation and microscopy of preparations of sample No. 2. Preparation of microscopic preparations, including their staining, was carried out according to the standard technique described in the article by Babaeva and Rogacheva (Babaeva & Rogacheva, 2012).

Genomic DNA extraction

The Genomic DNA of two isolates was extracted from yeasts cultures according to the procedure of MicroSeq® 500 16S rDNA Sequencing Kit protocol.

One mL of each yeast culture was added into a sterilized micro centrifuge tube with adding sodium dodecyl sulfate and protein-degrading enzyme. The samples were centrifuged for 15 min at 14,000 rpm using centrifuge DiaCent-CW® (Bio-Rad). The supernatant was discarded by suction apparatus FTA-1® (Biosan) and the pellets were washed with buffer pH 8 and centrifuged for obtaining pure pellets. DNA purification from protein impurities was performed by extraction with phenol/chloroform, 500 µl into each tube. The supernatant which include the extracted DNA was transferred into new micro centrifuge tube for using in the following step. 550 µl of isopropanol was

added to precipitate the DNA and the samples were centrifuged for 15 min at 14,000 rpm. After supernatant removal the precipitate was washed with 1 mL of 70% ethanol, dried and dissolved in 30–50 µl of TE. The DNA solution was stored at 4 °C.

Polymerase chain reaction (PCR)

The amplification of extracted DNA was carried out in ICycler® (Bio-Rad). The reaction volume for thermal cycling is 30 µL and the program of polymerase chain reaction is presented in Table 1. The PCR products were stored at minus 20 °C until use in the following step.

Table 1. The program of polymerase chain reaction

Primers	Annealing	Denaturation	Elongation
ITS1F/ITS2	52 °C/90 sec	92 °C/60 sec	72 °C/50 sec

Sequencing the PCR product

Polymerase chain reaction products were purified for removing the unused dNTPs and primers from the PCR mixture before sequencing. For sequencing used a set of standard reagents for the sequencer ABI PRISM 3500® (Thermo Fisher Scientific). Finally, the data were compared with the known data in basic alignment search tool (BLAST) with the degree of homology not less than 99%.

Statistical analysis

All experiments were performed in triplicate and the results were shown as the mean value ± the standard deviation. All microbiological counts were converted to the base -10 logarithm of cfus per milliliter (mL) of samples (log cfu mL^{-1}), and from these, means and their standard deviations were calculated.

RESULTS AND DISCUSSION

At the first stage of the work to substantiate the safety studied samples' quality, a study was made of the microbiological indicators of camel's raw milk (sample No. 1), which is of significant importance for the traditional method of producing shubat (sample No. 2). According to the results of microbiological methods of analysis, no pathogenic microorganisms, including *Salmonella*, were found in sample No. 1, the QMAFAnM indices do not exceed the permissible norm. In sample No. 2: bacteria of the group of *Escherichia coli* (coliforms), pathogenic microorganisms, including *Salmonella*, *St. Aureus* and mold are not found.

The content of inhibitory substances, in particular antibiotics, was not found in the test samples. Toxic elements such as cadmium and arsenic are not detected. The content of lead and mercury does not exceed the permissible norm, in particular, not more than 0.01 and 0.005 mg kg^{-1}, respectively. Radionuclides of cesium 137 and strontium 90 are within the limits of permissible norms. The presence of pesticides and aflatoxins in the samples was also not detected.

The physico-chemical properties of camel's raw milk (sample No. 1) were studied as the basis for the production of a sour milk drink – *shubat* (sample No. 2). According to the conducted studies (data of Table 2), the chemical composition of camel milk (sample No. 1) is within the limits of identification indicators values. Moreover,

identification indicators values of the camel milk chemical composition are much higher than cow's milk.

Table 2. The chemical composition of camel's raw milk (sample No. 1)

Indicators	Identification indicators of raw milk *		Research results
	Cow	Camel	of sample No. 1
titratable acidity, °T	16.00–21.00	not more than 17.50	17.10 ± 0.15
total solids, %	not less than 11.00**	on average 15.00	16.26 ± 0.18**
protein, %	not less than 2.80	not less than 3.80	5.09 ± 0.17
fat, %	not less than 2.80	not less than 3.00	5.52 ± 0.06
density under temperature 20 °C, kg m^{-3}	not less than 1,027.00	not less than 1,032.00	1,036.00 ± 0.30
freezing temperature, °C	not higher than -0.505	not standardized	-0.57 ± 0.50

* Technical Regulations of the Customs Union 'On the safety of milk and dairy products' (TR TS 033/2013) in accordance with the Unified Agreement principles and rules of technical regulation in the Republic of Belarus, the Republic of Kazakhstan and the Russian Federation on November 18, 2010.

** The calculation of dry matter of camel milk was performed according to the following formula: Total solids=MSNF+F.

The calculation of milk solids-non-fat in camel milk performed according to the following formula: Milk solids-not-fat (MSNF)=0.25×D+0.225×F+0.5, where: D – density (in degrees density hydrometer); F – fat content of raw milk, %.

In addition to the data presented in Table 2, other indicators of the chemical composition of sample No. 1 are also defined, in particular: ash – 0.75 ± 0.12%; lactose – 5.15 ± 0.10%; salts – 0.84 ± 0.15%. The values of indicators of identification of milk obtained from individual milkings described in Table 2 may vary within wider limits than in the data of technical regulations. Obviously, raw camel's milk, obtained from three different camels, varies insignificantly in terms of chemical composition. The revealed variability can be connected with the physiological condition of the animal, as the feeding conditions of all camels were the same. According to the results of the study, it can be stated that the titratable acidity is at an acceptable level. The content of protein, fat and dry substances significantly exceeds the established normalized values, which indicates the high nutritional value of camel milk obtained in the southern region of Kazakhstan. In particular, the protein content in the samples No. 1 varied from 5.38 to 4.80%, the fat content from 5.12 to 5.93%, the lactose content from 4.70 to 5.61%. In all the samples studied, the value of milk density exceeded the identification indicators with fluctuations from 1,034 to 1,038 kg m^{-3}, which indicates a high content of mineral salts in the studied camel milk: from 0.80 to 0.89%. As a result, camel milk, obtained from the southern region of Kazakhstan, showed compliance with the standards imposed on raw milk, which allowed further study of sample No. 2, obtained on the basis of sample No. 1.

At the second stage of the work, sample No. 2 was examined during storage. The parameters of the assessment at this stage of the experiment were changes in the active, titratable acidity and alcohol content for 21 days, with a storage interval of 7 days. The duration of the experiment is determined by the shelf life of the fermented product produced by the traditional method through spontaneous fermentation. The results of the study are presented in Table 3.

A high level of titrated acidity of sample No. 2 (Table 3) may be due to exposure to the microflora of camel's milk, which is actively developed in the process of spontaneous fermentation. Low values of active acidity of sample

Table 3. Change in active, titratable acidity and alcohol content during sample No. 2 storage

Storage days	Active acidity, pH	Titratable acidity, °T	Ethanol, %
0	4.81 ± 0.01	85 ± 0.15	0.68 ± 0.01
7	4.49 ± 0.01	168 ± 0.16	0.79 ± 0.01
14	4.24 ± 0.01	181 ± 0.16	0.91 ± 0.01
21	3.96 ± 0.01	191 ± 0.15	1.10 ± 0.01

No. 2 indicate a significant effect of lactic acid bacteria and yeast during spontaneous fermentation, which is confirmed by the organoleptic characteristics of the fermented product, in particular the formulation of the taste of the finished product as 'acidic'. It is obvious that camel's raw milk is an excellent medium for the development of native microflora inherent in this type of dairy raw materials.

For the initial detection of the microflora of the fermented milk product –*shubat*–a microscopic preparation of the freshly prepared sample No. 2 was prepared, the results of the experiment are shown in Fig. 1, a. The change in microbiological parameters of the sour milk drink (the number of lactic acid microorganisms, yeast) during the storage for 21 days is shown in Fig. 1, b. It is obvious that in the process of storage of sample No. 2, the amount of yeast increases, which leads to intense gas formation of the product, which is less pronounced in the freshly prepared fermented product.

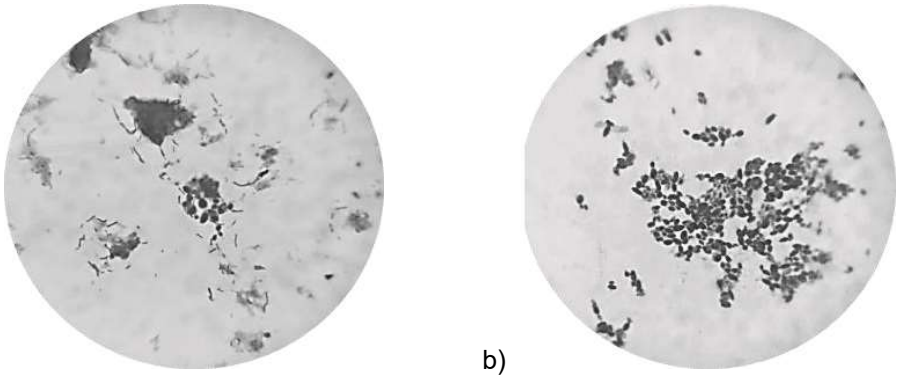

Figure 1. Microscopic preparations of sample No. 2 during storage, days: 0 day (a), for 21 days (b).

Based on the data in Fig. 1 it can be stated that the microscopic preparation of the freshly prepared product (Fig. 1, a) is represented mainly by lactic acid rods, which are located singly, in pairs and short chains, to a lesser degree there are yeast round and oval-ovoid in small groups. On day 21 of the experiment, a significant amount of yeast is developed in the microscopic preparation of sample No. 2, which develops during sample No. 2 storage (Fig. 1, b). However, this method of investigation is visual and requires confirmation by other methods.

In this connection, in the next stage of the study, the number of microorganisms in sample No. 2 was determined by the dilution method, culturing them on a nutrient medium followed by counting the grown colonies. A quantitative account of the browned up colonies was carried out in Goryaev's chamber with the purpose of revealing the

patterns of colony growth. The quantitative analysis of the grown colonies of the main groups of microorganisms of the finished fermented product on the 21st day of storage was conducted.

The quantity of lactic acid bacteria in sample No. 2 at the end of the shelf life is determined to be 1.93×10^6 CFU mL^{-1} and the yeast is 1.53×10^6 CFU mL^{-1}, which indicates a sufficiently high number of microorganisms in *shubat* prepared in the traditional way. As is known, *shubat* is obtained as a result of mixed fermentation, as evidenced by the results of the experiment.

Within the framework of this work, yeast, which caused alcoholic fermentation of camel milk, was of particular interest. To identify the specific composition of yeast, evidently inherent in the native microflora of camel milk, studies were carried out to isolate pure yeast cultures and identify them. In the course of the experiment on the isolation of pure yeast cultures of a fermented beverage – *shubat* – a microscopic preparation was evaluated (Fig. 2), as a result of which two preferred yeast types of a white and gray colony were identified. Fig. 2 clearly shows the morphological differences of yeast colonies, in particular, the yeast of the white colony has a rotundity and spherical shape (Fig. 2, a), and the yeast of the gray colony has a rodlike shape (Fig. 2, b).

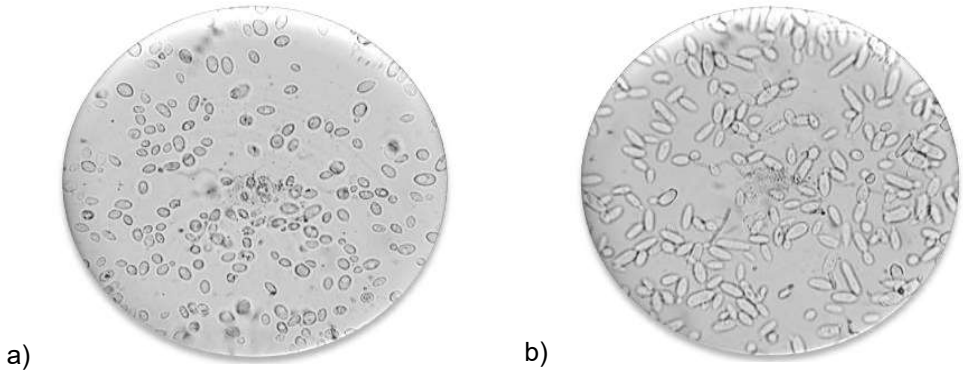

Figure 2. Microscopic preparations of pure yeast cultures isolated from sample No. 2.

The nucleotide sequences of two strains were analyzed by software application and data were compared with officially registered data. Molecular of the isolated pure yeast cultures of sample No. 2, in particular, the white and gray yeast colonies were genetically identified as *Brettanomyces anomalus* and *Naumovozyma castellii*, respectively. Specific features of the identified yeast are indicated in Table 4.

Table 4. Characteristics of the identified yeast colonies

White yeast colony	Gray yeast colony
Brettanomyces anomalus	*Naumovozyma castellii*
Optimal growth temperature: 31–32 °C	Optimal growth temperature: 24–26 °C
Aerobe	Aerobe
Strain: CBS 7654	Strain: CBS 4309

Yeasts of the genus *Brettanomyces anomalus* are characterized by increased degree of gassing, the production of high concentrations of ethanol, are thermotolerant. In the biotech industry, this kind of yeast is also used to produce bioethanol due their tolerance to low pH, nutrient-efficient metabolism and ability to produce high concentrations of ethanol (Passoth et al., 2007). *Brettanomyces* species can synthesize volatile phenolic compounds, including phenol, syringol (Heresztyn 1986) and several ethyl phenols (Chatonnet et al., 1997).

Yeasts of the genus *Naumovozyma castellii* are wild yeasts not used in the food industry. It should be noted that this type of yeast is widely used for research in the field of genetics. Yeast of the genus *Naumovozyma castellii* is widely used as a model organism in biological research. Due to the specific ability for genetic modification, this type of yeast becomes more and more interesting as a potential model of yeast for functional analyzes (Karademir et al., 2016).

Accordingly, of the two identified yeast species only the strain *Brettanomyces anomalus* can be used in the starter microflora for the production of fermented products produced under the action of mixed fermentation. The development of a complex starter based on strains of microorganisms isolated from camel milk will expand the range of fermented milk based products on an industrial scale.

CONCLUSIONS

Fermented dairy products based on camel milk are investigated to a lesser extent compared to products based on cow's milk. This is confirmed by the less informative regulatory framework for the milk of farm animals, with the exception of cow's milk and products based on it, the information of which are largely presented in the technical regulations. According to the results of a comprehensive research, it was proved that camel milk obtained in a number of farms in the southern regions of Kazakhstan has a high nutritional value and is assessed as a safe raw material resource. A fermented product based on camel milk was also studied, which showed compliance in terms of quality safety indicators. In consequence of the study, two species of yeast that cause the alcoholic fermentation of camel milk were isolated and identified. The experimental evidence on the identification of yeast colonies provide valuable insights of the microflora species diversity of camel milk. The present research will contribute to the development of new strains of microorganisms used in the production of starter microflora of fermented products in an industrial environment, thereby improving the quality and safety of fermented milk products.

Further research is planned on camel milk as a source of probiotic strains of lactic acid bacteria (LAB). The optimal approach in the future work will be a comprehensive assessment of camel milk microflora from various regions of Kazakhstan, which will provide extensive information on the strains of dairy microorganisms of camel milk and assess their role in the process of fermentation of dairy raw materials. In the future tense, it is scheduled to work on obtaining direct practice of starter microflora as a result of a combination of microorganisms' strains isolated from camel milk obtained in Kazakhstan.

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