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РЕСПУБЛИКИ КАЗАХСТАН

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STAGE VACUUM DRYING OF CAMEL MILK AND SHUBAT

Abstract. Processing of national dairy drinks in order to obtain long-lived commodities keeping own native properties is a topical issue of Kazakhstan food industry. A composition and medicinal properties of camel milk and national dairy drink "Shubat" is reported in the article. Drying till powder-like condition is the best preservation method.

At spray drying losses of dry product with outgoing drying agent (i.e. hot air) and its overheating are possible. In comparison to other drying methods vacuum-sublimation one requires high energy consumption. At vacuum-sublimation drying a liquid product is preliminary subjected to freezing because it is thought that drying of liquid milk or dairy product in vacuum is impossible due to its foaming and kicking over a capacity. Experimental data confirm that at definite vacuum level and heating temperatures phenomenon similar to camel milk boiling is observed. Especially strongly this phenomenon is observed at drying of Shubat that is explained by presence carbonic gas into it. Drying of dairy products into vacuum medium without preliminary freezing will increase intensity of dehydration process and decrease energy demands.

A technology of stage vacuum drying of camel milk and Shubat without their freezing has been developed. Mode of camel milk vacuum drying consists of four stages and is carried out at vacuum level (3-6) kPa and heating temperature (18-20) ^{0}C. Mode of Shubat vacuum drying is more complex because of presence of carbonic gas in it and consists of six stages, vacuum level (3-10) kPa and heating temperature is the same. A construction of experimental vacuum dryer has been presented. The optimal regimes of vacuum drying of these products have been defined. Ready powders of camel milk and Shubat have good sensory indicators and rehydrated properties.

Keywords: vacuum, drying, stage, dryer, camel milk, shubat.

Introduction. In Kazakhstan camel milk and its dairy drink "Shubat" are widely used in food. Camel milk is different by high content of fats, proteins, mineral substances and other valuable elements therefore it is considered as a high-nutritious food. Usually camel milk has pure white colour, flattish-sweet or sweetish-salty taste depending on camel feeding, dense consistency, at pouring-over it is strongly foamed. Mal and Pathak (2010) thoroughly described camel milk composition and products obtained from it in India. Grigor'yants (1954) compared chemical compositions of camel milk and Chal (Turkman analog of Shubat). Dikhanbayeva (2010) investigated a chemical composition of milk of Almaty region (Kazakhstan's district) camels of *Camelus dromedaries* breed in every year season.

Shyngissov and Nurseitova (2013) found out the presence of such macro- and microelements as titanium, strontium, argentums, tellurium, stannic, niobium, tantalum, etc. in a mineral composition of milk and Shubat from camels of South Kazakhstan.

Camel milk and Shubat possess by many medicinal properties. Camel milk is used for treating dropsy, jaundice, spleen ailments, tuberculosis, asthma, anemia and piles (Rao et al. 1970). The patients suffering from chronic hepatitis had improved liver functions after drinking of camel milk (Sharmanov et al. 1978). Yagil (1982) suggested that camel milk contains protective proteins which may have possible role for enhancing immune defense mechanism. Camel milk also contains higher amount of zinc. The rapidly dividing cells of the immune system are sensitive to zinc deficiency. The role of Zn in the development and maintenance of a normally functioning immune system has been well established (Hansen et al. 1982). Antibacterial and antiviral activities of these proteins of camel milk were studied (El-Agamy et al. 1992). Lysozyme of camel milk showed a higher lysis value towards Salmonella typhimurium compared to egg white and bovine milk lysozymes. The inhibition of pathogenic bacteria by camel's milk was also observed (Barbour et al. 1984). Camel milk has insulin like activity, regulatory and immunomodulatory functions on β cells (Breitling, 2002).

Camel milk exhibits hypoglycemic effect when given as an adjunctive therapy, which might be due to presence of insulin like protein in it (Agrawal et al. 2003) and possesses beneficial effect in the treatment of diabetic patients. Camel milk has been used for the treatment of autism (Shabo and Yagil, 2005a) and food allergies (Shabo et al. 2005b). Camel milk can be used for the treatment of different types of tuberculosis (Mal et al. 2000, 2001 and 2006). Camel milk possesses medicinal properties to treat different ailments such as multiple sclerosis, psoriasis, lupus, allergies-asthma (Wernery, 2006). Camel milk drinking has shown a good effect for treating crohn's disease (Shabo et al. 2008). Shubat promotes curing of tuberculosis and gastric ulcer, normalizes the activity of sweetbread, stomach, liver and enhances organism resistance to infectious diseases (Sharmanov, 1991).

All of these medicinal properties are peculiar to fresh camel milk. But it was found that camel milk does not sour at temperatures below 10°C and this for up to 72 hours. At 30°C the milk sours in approximately 8 hours. Shubat sours after a day. At temperature below 5^0C it is possible to elongate shelf life of Shubat that is impossible without a refrigerator.

Therefore processing of national dairy drinks in order to obtain long-lived commodities keeping own native properties is a topical issue of Kazakhstan food industry. It is thought that drying till powder-like condition is the best preservation method. There are many Kazakhstani scientists have been investigating dairy drying. Their investigations are related to modernization of spraying and vacuum-sublimation drying methods. So, Omaralieva, Chomanov and Shyngissov (1999) have created optimal design of atomizing disk and defined its position in a drying chamber in order to provide high monodisperse degree of dry products. Seitov developed the method of vacuum-sublimation drying of mare's milk and kumiss - fermented mare's milk (1997).

At spray drying losses of dry product with outgoing drying agent (i.e. hot air) and its overheating are possible. In comparison to other drying methods vacuum-sublimation one requires high energy consumption. It is known that at vacuum-sublimation drying a liquid product is preliminary subjected to freezing because it is thought that drying of liquid milk or dairy product in vacuum is impossible due to its foaming and kicking over a capacity. Actually, experimental data confirm that at definite vacuum level and heating temperatures phenomenon similar to camel milk boiling is observed. Especially strongly this phenomenon is observed at drying of Shubat that is explained by presence carbonic gas into it. Meanwhile, drying of dairy products into vacuum medium without preliminary freezing will increase intensity of dehydration process and decrease energy demands.

Taking into account above mentioned facts, experimental vacuum drying installation and technology of stage vacuum drying of camel milk and Shubat (Khanzharov et al.2011) in unfrozen view have been created.

Methods. Investigations have been carried out on the developed experimental vacuum drying installation as shown on the figure 1. The installation is based on vacuum chamber 1 made in view cylinder capacity with hermetically closed lid. There are shelves 2 installed into the chamber for placing drying material. Vacuum pump 3 connects to vacuum chamber and allows keeping necessary meaning of atmosphere pressure into it. Degree of vacuum is regulated by valve 4. Refrigerating system is included in the scheme in order to most effective removing evaporated moisture from a product. Refrigerating agent is Freon. Refrigerating system consists of single-stage compressor 8, refrigeration condenser 12 with free air circulation, filter-drier 11, expansion device 10 in view capillary tube and evaporator apparatus 7. Evaporator apparatus is connected with freeze-out device 5 which services to freeze out moisture evaporated from dried material. Frozen out moisture is periodically defrosted and poured out through valve 9 into condenser capacity 13. Refrigerating agent boils in serpentine pipe installed into inner tube of freeze-out device. At boiling a refrigerating agent takes away heat from coolant which circulates in tubular annulus. Circulation of coolant between evaporator apparatus and freeze-out device is carried out by the means of fluid pump 6. Coolant (antifreeze A-40) is given into inner tube of freeze-out device. It removes heat of condensation and crystallization of evaporated steam from a product which is located in tubular annulus. External surface of these heat exchangers are covered by heat-insulation material - foamed polyurethane in order to prevent heat penetration from environment.

The drying installation is equipped by measuring devices to register indications of pressure and temperature in basic dryers' elements, electric potential and current intensity in electrical gauges and support devices. Atmosphere pressure in vacuum chamber is measured at low vacuum by pointer vacuum gauge 14 and at high vacuum – by ionization-thermocouple vacuum gage 15.

Temperature in chamber is measured by wiry resistance thermometer 23. Secondary instrument at indication vacuum chamber by temperature is universal measuring device 24. Temperature of condensation and crystallization moisture in freeze-out device and temperature of boiling of refrigerating agent in evaporator apparatus is measured by copper-constantan thermocouple 28 stacked up of corresponded heat exchanger. Ends of thermocouples are immersed in melted ice into glass thermos flask 26. All of thermocouples through position switch 27 are connected with digital millivoltmeter 25. Current intensity and electric potential indications are measured by the means of pointer amperemeter 20 and voltmeter 21. Automation system controls temperature of heating of chamber's body by the means of contact thermometer 17 and at given temperature it cuts off electrical heaters 16. Contact thermometer and electric transformer 19 are plugged in power lines through regulating starting arrangement 18.

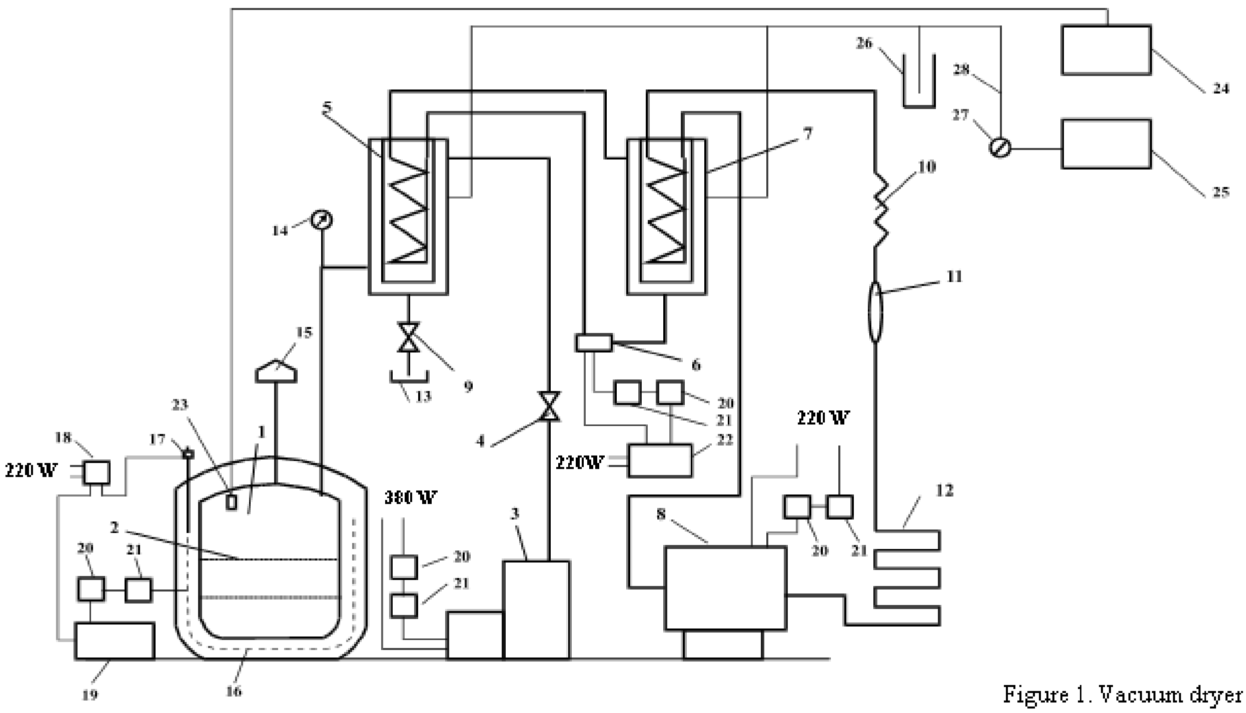


Figure 1. Vacuum dryer

Experimental investigations are carried out in the following order.

1. 30 minutes before starting experiment in order to prepare drying installation the compressor and electrical heaters are run. Necessary temperature of boiling of refrigerating agent (-15;-10;-4^{0}C) is set by regulation of expansion device. Atmosphere temperature in vacuum chamber is regulated in the limit (35÷45) ^{0}C by changing current intensity giving to electrical heaters by laboratory current transformer.
2. Prepared material (camel milk or Shubat) is put in preliminary dried glass capacities by the diameters 3-5 cm and height 12 cm. Material thickness of layer is 1.7-2.0 cm.
3. Mass of material is weighted on analytic balance with on accuracy 0.001g.
4. Capacities are placed on shelves into vacuum chamber. Lid is closed compactly.
5. Vacuum pump is gone on. Vacuum level in the chamber (2; 4; 6; 8; 10 kPa) is set up by expansion valve. Moment of beginning of an experiment is fixed after achieving necessary level of vacuum.

6. Time interval between measurements of mass of dried material is 60 minutes. At that amount of evaporated moisture is defined. At first by the means of expansion valve vacuum level in the chamber is decreased till 0.08 atm; then vacuum pump is switched off and lid is opened.

7. Moisture content in the material is calculated by the formula:

$$\omega = \frac{m_1 - m_2}{m_1} 100, \% ,$$

where ω – material moisture content relative to its initial mass, %; m_1 and m_2 – initial and final material masses, g.

8. Weighted material is placed in vacuum chamber and dried again.

Camel milk of summer yield from camels of South Kazakhstan has been investigated in the work. Shubat is prepared from this milk. Initial moisture content in camel milk is 87.5%, Shubat – 88.5%. Final moisture content in camel milk and Shubat is 4%.

Results. At carrying out the investigations in contrast to vacuum-sublimation drying vacuum level in the chamber was in the limit (3-10 kPa) that is be classified as low and medium vacuum [Shumsky et al. 1967, Novikov et al. 1971]. It has been found that foaming and kicking off milk and Shubat from a capacity is observed at the moment of making vacuum and their heating. Therefore it was solved to not increase heating temperature above environment one and to maintain at the level (18-20)^{0}C. This temperature level allows not only keep vitamins but useful microorganisms of Shubat which at drying is transferred into anabiotic state.

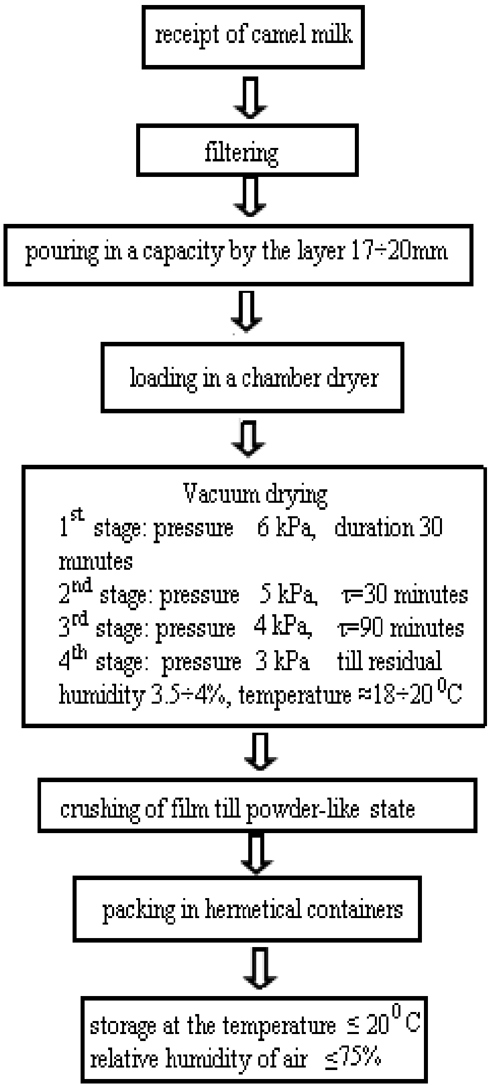


Figure 2. Technological scheme of camel milk stage vacuum drying

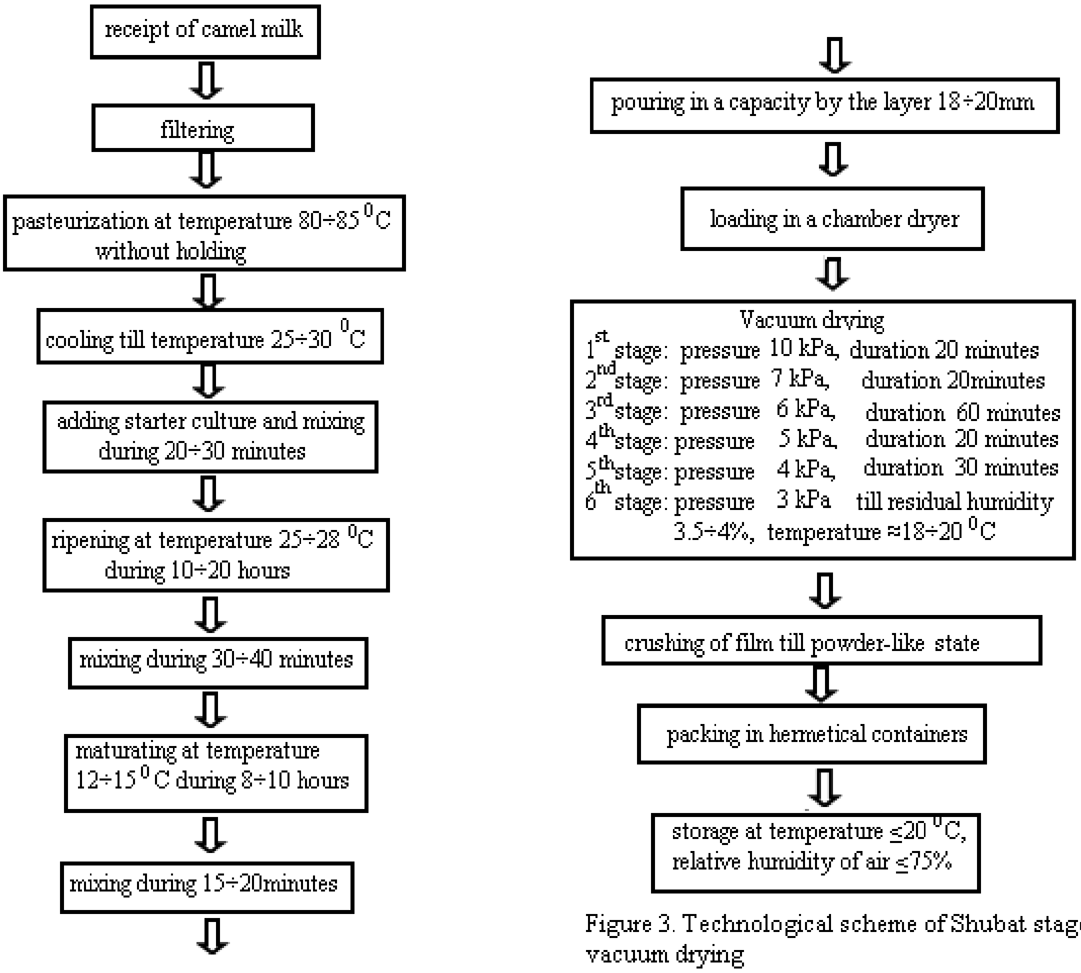


Figure 3. Technological scheme of Shubat stage vacuum drying

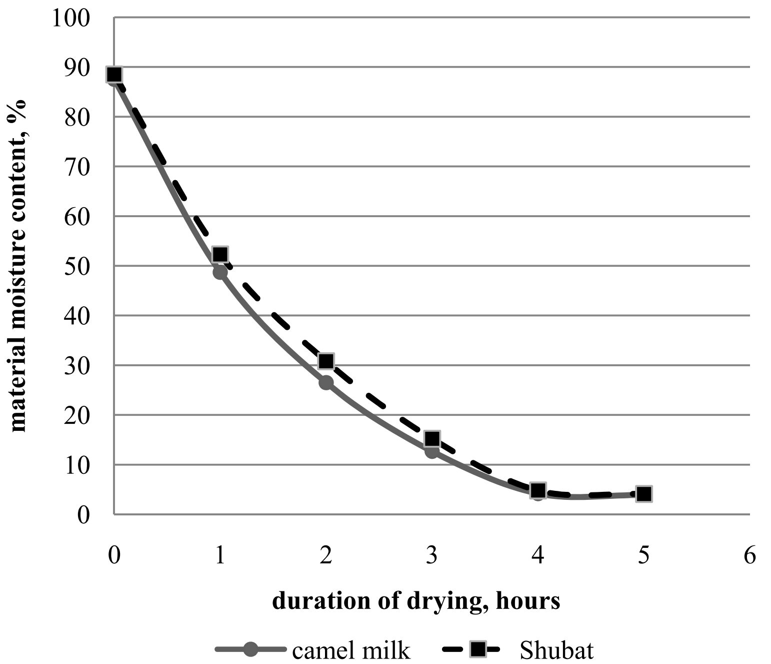
Discussion. It was defined that it is possible to control foaming and kicking of milk or Shubat by selecting temperature and changing pressure level. At this the mode of moderate "boiling" of milk is created. Similar method by excluding foaming of product has been developed by Komyakov et al. (1989) for sublimation drying of concentrated liquid food products. In order to intensify drying a pressure into a chamber is increased at the rate of 50-70 Pa/sec till 200-2500 Pa and following holding during 20-30 sec.

When during drying humidity of milk is decreased and at given vacuum level moderate "boiling" is stopped it is possible to increase vacuum level, achieving previous hydrodynamic mode of milk state. So, vacuum drying may be carried out in several stages. Every following stage is carried out at more high vacuum level then previous one. In comparison to constant vacuum meaning it is possible to intensify drying process by stage-by-stage increasing vacuum level. Cyclical increasing of vacuum level is used at drying of disperse materials (Labutin et al. 1987). There are technological schemes of stage vacuum drying of camel milk and Shubat developed on the base of investigation results (figures 2 and 3). Operations of milk and Shubat processing before and after drying are traditional ones and include such operations as receipt, filtering, pasteurization, ripening, mixing, packing in hermetical containers etc.

Mode of camel milk vacuum drying consists of four stages and is carried out at vacuum level (3-6) kPa and heating temperature (18-20) ^{0}C. Mode of Shubat vacuum drying is more complex because of presence of carbonic gas in it and consists of six stages, vacuum level (3-10) kPa and heating temperature is the same. The same vacuum level is used by Shabetnik (1999) at first period of cold vacuum drying of liquid-viscous materials.

It is found that duration of stage vacuum drying of camel milk and Shubat is about 4 hours (Khanzharov et al. 2011). Drying curves of camel milk and Shubat are shown on the figure 4. Ready powders of camel milk and Shubat have good organoleptic indicators and possess by good rehydration properties.

Figure 4. Curves of camel milk and Shubat stage vacuum drying



Stage technology of vacuum drying compare to existing analogs allows not only keep good quality of dried milk products but significantly intensify drying process and pull down energy consumption.

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Б. Т. Абдижаппарова[1], Н. С. Ханжаров[1], О. Б. Оспанов[1], А. В. Бараненко[2], А. А. Досмаканбетова[1]

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ЭТАП ВАКУУМНОЙ СУШКИ ВЕРБЛЮЖЬЕГО МОЛОКА И ШУБАТА

Аннотация. Переработка национальных напитков для получения продуктов длительного хранения с сохранением природных свойств является актуальной проблемой для пищевой промышленности Казахстана. В статье сообщается о составе и лечебных свойствах верблюжьего молока и национального молочного напитка шубат. Сушка до порошкообразного состояния является лучшим методом консервации.

При распылительной сушке возможны потери сухого продукта с отходящим сушильным агентом (т.е. горячим воздухом) и его перегрев. По сравнению с другими методами сушки вакуумная сублимация требует больших энергозатрат. При вакуумно-сублимационной сушке жидкий продукт предварительно подвергается замораживанию, так как считается, что сушка жидкого молока или молочного продукта в вакууме невозможна из-за его вспенивания и выброса над емкостью. Экспериментальные данные подтверждают, что при определенном уровне вакуума и температурах нагрева наблюдается явление, аналогичное кипению верблюжьего молока. Особенно сильно это явление наблюдается при сушке шубата, что объясняется присутствием в нем углекислого газа. Сушка молочных продуктов в вакуумной среде без предварительного замораживания повысит интенсивность процесса обезвоживания и снизит энергозатраты.

Разработана технология ступенчатой вакуумной сушки верблюжьего молока и шубата без их замораживания. Режим вакуумной сушки верблюжьего молока состоит из четырех этапов и осуществляется на уровне вакуума (3-6) кПа и температуры нагрева (18-20) ^{0}C. Режим вакуумной сушки шубата более сложен из-за наличия в нем углекислого газа и состоит из шести ступеней, уровень вакуума (3-10) кПа и аналогичная температура нагрева. Представлена конструкция экспериментальной вакуумной сушилки. Определены оптимальные режимы вакуумной сушки этих продуктов. Готовые порошки из верблюжьего молока и шубата обладают хорошими органолептическими показателями и регидратационными свойствами.

Ключевые слова: вакуум, сушка, стадия, сушилка, верблюжье молоко, шубат.

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ТҮЙЕ СҮТІ МЕН ШҰБАТТЫ ВАКУУМДЫҚ КЕПТІРУ КЕЗЕҢІ

Аннотация. Қазақстан тамақ өнеркәсібінің алдында тұрған басты мәселесі – ол ұлттық сусындарды өңдеу нәтижесәнде табиғи қасиеттері сақталынған және сақтау мерзімі ұзартылған өнімдерді алу болып табылады. Мақалада түйе сүті мен шубат ұлттық сусынының құрамы мен емдік қасиеттері туралы айтылған. Ұнтақ түріне дейін кептіру консервілеудің ең тиімді тәсілі болып табылады.

Шашыратқыш кептіруде құрғақ өнімның біршамасы қайтарылатын кептіргіш агентпен (яғни, ыстық ауа) жоғалып, аса қызып кету мүмкін. Кептірудің басқа тәсілдеріне қарағанда вакуумдық сублимация жоғары энергия шығындарын қажет етеді. Вакуум-сублимациялық кептіруде сұйық өнім алдын-ала мұздатылады, себебі қайнау мен шашыраудың себебінен сұйық өнімді вакуумда кептіруге мүмкін емес деп есептелінеді. Тәжірибе мәліметтері бойынша, вакуум мен температураның белгілі деңгейінде түйе сүтінің қайнауына ұқсайтын құбылыс орын алады. Әсіресе, бұл құбылыс шубатты кептіруде қатты байқалады, себебі оның құрамында көмірқышқыл газы бар. Вакуум ортасында сүт өнімдерінің алдын ала мұздатпай кептірілуі ылғалсыздану процесінің қарқындылығын жоғарылатып, энергия шығындарын төмендетеді.

Түйе сүті мен шубаттың сатылы вакуумдық кептіру технологиясы құрастырылған. Түйе сүтінің вакуумдық кептіру режимі төрт сатыдан тұрады және (3-6) кПа вакуум деңгейінде (18-20) ^{0}С температурасында өтеді. Түйе сүтінің вакуумдық кептіру режимі көмірқышқыл газының барлығынан күрделі болып, ол алты сатыны құрайды және (3-10) кПа вакуум деңгейінде және ұқсас температурасында өтеді.

Вакуумдық кептіргіштің тәжірибе жүзінде қолданылатын құрылысы ұсынылады. Аталған өнімдердің тиімді вакуумдық кептіру режимдері анықталды. Түйе сүті мен шубаттың ұнтақтары жақсы органолептикалық және регидратациялық қасиеттеріне ие.

Түйін сөздер: вакуум, кептіру, кезең, кептіргіш, түйе сүті, шұбат.

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