UDC 637.142.2

https://doi.org/10.52058/2786-6025-2023-3(17)-492-502

Hajiyeva Bahar  Doctor of Philosophy in Technical Sciences, Senior Lecturer, Ganja State University, Ganja, Azerbaijan, https://orcid.org/0000-0001-6101-5714

TECHNOLOGICAL PROCESS OF PRESERVATION AND ENRICHMENT OF MILK COMPOSITION

Abstract. The aim of the article is to consider issues related to the technological process of preserving and enriching the composition of milk. It is noted that milk, which is of great importance in nutrition due to the presence of proteins, fats, minerals and vitamins in its composition, may contain elements that in some cases can threaten human health. In addition, it is emphasized that the production of high-quality dairy products can only be achieved with the high quality of raw milk used as a raw material. In addition to the physical and chemical quality of raw milk, its biological quality is also an important factor. This study emphasizes that the physical, chemical and biological content of milk in terms of human health and product quality, as well as enrichment with minerals and vitamins, is necessary for a person.

Used techniques and methods. To do this, first of all, the composition of raw milk was briefly reviewed, as well as scientific studies on bacteria in raw milk and microbes harmful to human health were analyzed. It then discusses the manufacturing processes to which milk is subjected and the technologies for enriching its composition. For this, data were used on the content of milk, changes in the content of milk in the process of processes, the amounts of vitamins and minerals added to milk.

Main novelty. The novelty of this study lies in the study of the process of milk processing and enrichment of its composition with minerals and vitamins beneficial to human health using the latest scientific data.

The main result of the study: The quality of dairy products is directly proportional to the quality of raw milk used as a raw material. In addition to the physical, chemical and organoleptic qualities of the raw milk to be processed, its biological quality is also an important factor. Even if raw milk is suitable in terms of biological properties, heat treatment is a mandatory process to avoid any risk before processing. In this regard, in order to obtain quality raw milk, milk producers and enterprises must be informed and trained on this issue.

In the process of fortifying milk with vitamins, a number of key factors should be taken into account. These factors are technological, legal, economic or health-related factors. In addition, the storage conditions of milk until it reaches the
consumer directly affect its quality and the preservation of its vitamin value.

**Keywords:** milk, milk composition, dairy technologies, separation process, human health.

Гаджієва Бахар Доктор філософії з технічних наук, старший викладач, Гянджинський державний університет, Гянджа, Азербайджан, https://orcid.org/ 0000-0001-6101-5714

**ТЕХНОЛОГІЧНИЙ ПРОЦЕС ЗБЕРЕЖЕННЯ І ЗБАГАЧЕННЯ СКЛАДУ МОЛОКА**

Анотація. Мета статті розглянути питання, що пов’язані з технологічним процесом збереження та збагачення складу молока. Зазначається, що молоко, що має велике значення в харчуванні завдяки наявності в його складі білків, жирів, мінеральних речовин і вітамінів, може містити елементи, які можуть призвести до загрожування здоров'ю людини. Крім того, підкреслюється, що отримання якісних молочних продуктів може бути досягнуто тільки за високої якості сирого молока, що використовується як сировина. Крім фізичної та хімічної якості сирого молока, важливим фактором є також його біологічна якість. У цьому дослідженні наголошується, що фізичний, хімічний та біологічний вміст молока з точки зору здоров'я людини та якості продукту, а також збагачення мінералами та вітамінами необхідне людині.

Використовувані методики та методи. Для цього вперше було коротко розглянуто склад сирого молока, а також проаналізовано наукові дослідження про бактерії в сирому молоці та шкідливі для здоров'я людини мікроби. Потім обговорюються виробничі процеси, яким піддається молоко, та технології збагачення його складу. Для цього використовувалися дані про вміст молока, зміну вмісту молока в процесі процесів, кількість вітамінів і мінеральних речовин, що додаються в молоко.

Основна новизна. Новизна цього дослідження полягає у вивченні процесу переробки молока та збагачення його складу корисними для здоров'я людини мінералами та вітамінами з використанням новітніх наукових даних.

Основний результат дослідження: Якість молочної продукції прямо пропорційна якості сирого молока, що використовується як сировина. На додаток до фізичних, хімічних та органолептичних якостей сирого молока, що підлягає переробці, його біологічна якість також є важливим фактором. Навіть якщо сире молоко підходить з точки зору біологічних властивостей, термічна обробка є обов’язковим процесом, щоб уникнути ризику перед переробкою. У зв'язку з цим, щоб отримати якісне сире молоко, виробники молока та підприємства мають бути поінформовані та мають бути проведені тренінги з
У процесі збагачення молока вітамінами слід враховувати низку основних факторів. Ці фактори є технологічними, юридичними, економічними чи факторами, пов'язаними зі здоров'ям. Крім того, умови зберігання молока до моменту його надходження до споживача безпосередньо впливають на його якість та збереження вітамінної цінності.

Ключові слова: молоко, склад молока, молочні технології, процес сепарації, здоров'я.

Introduction (problem statement). Milk goes through various processes in the industry before it is offered to the consumer as drinking milk or various dairy products. Chemical and physical changes occur in milk components according to the applied process and the exposures. As milk components undergo structural and chemical changes, their quantity may increase or decrease. Milk proteins, milk lipids, milk sugar, which are the main components of milk, undergo changes or decrease in quantity during the production process, due to the influence of that process or other factors, and the vitamin and mineral content of milk decreases at the micro level.

Tools and equipment such as containers, carriers, tankers required for milking, collection and transportation that will come into contact with milk should be made of materials that can be cleaned easily, disinfected, resistant to corrosion and will not pose a danger to human health or adversely affect the sensory properties of milk and will not pass into milk. Containers and devices used in milking that come into contact with milk should be cleaned and disinfected immediately after use.

The scientific articles published on the subject in recent years contain interesting facts about the physical, chemical and biological composition of milk and the elimination of harmful micro-organisms in it. Milk has a very complex structure. Although compositional values differ according to their origin, all dairy products mainly contain water, protein, lactose (milk sugar), fat, minerals, vitamins, enzymes and some other chemical components (Özer, 2006: 68).

The type and quality of raw milk to be used in the production of dairy products is important in terms of product quality. In this respect, the physical, chemical and sensory properties of raw milk are an issue that should be emphasized. The milk to be used in production must be obtained from healthy animals, its sensory properties and chemical composition must be normal, its biological quality must not be changed, it must be fresh, clean and of good quality. Cow's milk is the most widely used and technologically important type of milk in the production of many dairy products. It is possible to add sheep, goat or buffalo milk to cow's milk in different proportions or to obtain products only from such milk.

The following factors should be considered in the selection of milk to be used in the production of various dairy products (Temiz, 2003: 167):
- Milk must be normal physically and chemically. It should have a balanced amount of mineral substance.
- Milk must be flawless in terms of sensory properties such as color, taste, smell and appearance.
- The amount of casein should be high.
- Milk containing antibiotics and similar substances should not be used.
- It should not contain detergent and disinfectant residues.
- Its acidity should not be less than 6.0 °SH and higher than 7.0 °SH.
- The optimum storage temperature for raw milk should be between 6 – 8 °C.

The color and smell of the milk should be unique. The effect of the feeds fed to the animal on color and odor is high. In addition, since milk is an odor-repelling substance, storing it in bad-smelling places such as barns causes it to attract unwanted odors. Milk is slightly sweetish because of the lactose it contains. Apart from this taste, as a result of the activity of some bacteria, sour taste, salty taste in the milk obtained from the diseased udder, and unwanted taste passing through the feeds can be encountered.

Milk and dairy products, which have an important place for human health, can sometimes cause the transmission of diseases caused by microorganisms contaminated for various reasons. Due to the substances in its composition, it is a very good environment for the development of many microorganisms. For this reason, various microorganisms that contaminate raw milk from air, feed, barn, water and similar environments during storage multiply rapidly and cause undesirable changes in various qualities of milk. Infected milk can be contaminated with some microorganisms in the milked animal, or it can be transmitted by the patient or the porter, the milker or the seller (Demirel, 2007: 19-20).

Systemic diseases may result in the establishment of pathogens in the mammary glands and lymph nodes and the presence of pathogens in the expressed milk. Bovine tuberculosis and brucellosis are classic examples of zoonotic dairy-borne diseases. The contribution of cattle to the epidemiology of these 2 diseases in humans is so important that much effort has been made to eradicate these infections among cattle in the USA. The programs implemented have been widely successful and Mycobacterium bovis and Brucella abortus have been observed very rarely in home-raised cattle.

Unlike Mycobacterium bovis and Brucella abortus, many other organisms today are asymptomatic, found in bovine and goat milk or the milk is contaminated from environmental sources. These; Coliforms such as Coxiella burnetii, Listeria species, Mycobacterium avium subspecies paratuberculosis, Campylobacter species, Salmonella and E.coli. Bovines can be the main source of these organisms, and yet animals can still remain healthy and produce near-optimal milk. For example; C. burnetii, the causative agent of Q fever, is not an important cause of clinical disease in cattle; however, the frequency of recurrence in milk collected
from farms in the USA was reported as 94% based on PCR analysis (LeJeune, Rajala-Schultz, 2009: 95).

In addition, its rich nutritional content and neutral pH make milk a very good source for the survival and growth of bacteria. Generally speaking, growth of other species other than psychrophilic organisms, such as Listeria, can be halted if milk is properly refrigerated. Unfortunately, development prevention is not sufficient to ensure milk safety. However, even a small amount of pathogens is sufficient to cause disease in humans. Therefore, the presence of pathogens in milk is very important. As a result, natural and complex interactions in the initial microflora give an idea about whether pathogens can survive in milk (Morgan, 2001: 219).

There are 2 main factors affecting the microbiological quality of milk: the presence of organisms in the expressed milk (premilking) and contamination of the milk during collection, processing, distribution and storage (post milking). If pathogens are present among the contaminants, the product will pose a threat to food safety. Many approaches are applied to minimize the delivery of milk contaminated with pathogens to the consumer (LeJeune, Rajala-Schultz, 2009: 99). Salmonella strains can be frequently encountered in the milk of Salmonella-infected animals and in dairy farms. It is possible to detect this bacterium, which is extremely resistant to drying, freezing, low pH, and storage in cold and hot environments, in milk and dairy products that have been prepared under inadequate sanitation conditions, as well as in raw milk. Bacteria, which can develop easily especially during cheese production, can maintain their vitality for more than 60 days at 4-7 °C (Durlu-Özkaya, Cömert, 2008: 153-154).

Staphylococcus aureus is another microorganism frequently seen in milk and its products. Especially milk from animals with mastitis is enteropathogenic Staph. aureus is an important source of strains. Staphylococcus poisoning caused by cheese is seen from time to time and studies on this subject show that Staphylococcus aureus develops during the cheese making process and produces toxins (Durlu-Özkaya ve Cömert, 2008: 154).

Contamination Control Strategies. Large-scale dairy producers fulfill their responsibilities to ensure that the products they produce do not pose a problem in terms of safety and human health. The quality and hygiene of the raw materials to be used in production is important not only for human health, but also for the profit of the producers. However, many dairy producers are unaware of most potential bacterial contaminants in milk (LeJeune, Rajala-Schultz, 2009: 208).

Minimizing the contamination of milk, which has an important place in human nutrition in terms of the nutrients it contains, and making raw milk safe before processing is an important issue. Depending on the type of product to be produced, raw milk is made ready for production using many techniques. Among these techniques, pasteurization and commercial sterilization are the most used. In all methods, the main objective is to destroy the vegetative and/or spore forms of
pathogenic microorganisms. These processes are mentioned below (Türk Qida Kodeksi, 2000: 16):

**Pasteurization.** It is the heat treatment carried out in order to reduce the number of all vegetative forms of pathogenic microorganisms in milk, a large part of other microorganisms, extends the shelf life of milk, results in minimal physical, chemical and sensory changes, and is carried out at minimum 72 °C for 15 seconds or other equivalent conditions.

**Ultra High Temperature (UHT).** UHT - heat applied under short-term continuous flow at high temperature at a suitable time-temperature combination, at least in 1 second at 135 °C, to produce a commercially sterile product that can be stored at room temperature: destroys all microorganisms and their spores that will cause deterioration under normal storage conditions. process.

**Sterilization.** In order to produce a commercially sterile product that can be stored at room temperature, the hermetically packaged product that destroys all microorganisms and spores that will cause deterioration under normal storage conditions, at a suitable time-temperature combination such as at least 13 minutes at 115 °C or 3 minutes at 121 °C, It is a long-term heat treatment at high temperature. The heat treatment time applied to the milk and the applied temperature are extremely important. Considering the nutritional value, the nutrients most affected by the applied heat treatment are vitamins. However, it is known that there is no great difference between the losses observed in the nutritional value of milk by pasteurizing the milk or bringing it to a long-lasting state (UHT) (Altun, 2002: 53-54).

**Technology of adding ingredients to milk.** Milk goes through various processes in the industry before it is offered to the consumer as drinking milk or other dairy products. Chemical and physical changes occur in milk components according to the applied process and the exposures. As milk components undergo structural and chemical changes, their quantity may increase or decrease. Milk proteins, milk lipids, milk sugar, which are the main components of milk, undergo changes or decrease in quantity during the production process, due to the influence of that process or other factors, and the vitamin and mineral content of milk decreases at the micro level (Hurrell, 1992: 82).

The most basic process for drinking milk is the heat treatment process. The most common heat treatment methods on an industrial scale are pasteurization, UHT, and sterilization. Many milk components undergo certain vitamin-mineral loss during this process, depending on the temperature-time relationship of heat processing. Depending on the type of heat treatment, some of the heat-sensitive vitamins are lost during heat treatment.

In the production of drinking milk, milk fat is separated from milk in certain proportions according to commercial and technological goals in most countries. As a result, fat-soluble vitamins are separated from milk, which losses are compensated by the addition of ingredients.
In most countries, milk is fortified with vitamins A and D. Some companies in America and Europe even enrich their milk with vitamins C and E and calcium, in addition to vitamins A and D.

The most important factor necessitating the enrichment of drinking milk with vitamins A and D is that these vitamins, which are extremely important for a healthy life, are not sufficient in milk to meet the daily needs of a person, and they are lost due to various factors during milk processing.

First of all, the vitamin content of drinking milk to be enriched with vitamins, the maximum and minimum ratios to be enriched should be determined. Enrichment at a level below the norm will not achieve its goal, and the enrichment processes carried out in an excessive dose lead to the accumulation of vitamins in the body with a higher dose than the norm and have a toxic effect. The permitted addition of vitamin D for homogenized drinking milk is a maximum of 600 IU per liter of milk, and the addition of vitamin A is a maximum of 6000 IU per liter of milk. These values are the values that appear when the enrichment is between 100-150% (Hurrell, 1992: 86-87).

The most important factor that makes it necessary to add vitamins A and D to drinking milk is the fact that these vitamins, which are extremely important for the healthy continuation of human life, are not present in milk in the amount that meets the daily needs of a person, and even the low level of vitamins present in milk due to the influence of various factors in the milk processing process. fall. Especially for children who need these vitamins the most, it is extremely important to enrich milk with vitamins A and D, to support their healthy development.

If some factors are taken into account, the technology of milk enrichment is not very complicated. Vitamins and minerals to be added are added to milk in powder form. However, the addition of fat-soluble vitamins to milk is usually done in a fat-soluble form. If not only fat-soluble vitamins are added to milk, but also other vitamins and minerals, fat-soluble vitamins are added to cold milk as a premix.

Applied technological processes are carried out in the following order (Harris, 1988: 4):
- Addition of fat-soluble vitamins to cold milk in a fat-soluble form;
- Homogenization process;
- Addition of other vitamins and minerals (in powder form), if added;
- Mixing process;
- Waiting;
- Second mixing operation;
- Pasteurization;
- Milk cooling;
- Packaging of milk.

Dependence of preservation of vitamin value of milk on packaging and storage conditions. Even if the milk is not subjected to the heating process, the
amount of vitamins A and D in its content is not enough to meet the daily needs of the consumer for these vitamins. So, in the indicators of the World Health Organization, the norm of vitamin A for children is 2000-3000 IU and for adults 5000 IU; Vitamin D is 600 IU for children and pregnant women, and 800 IU for adults.

Both after the pasteurization and heating process, the amount of vitamins A and D, which are present in milk and do not meet human needs, further decreases. With the additions, the amount of vitamins A and D in packaged drinking milk is increased to the daily norm.

Packaging and storage conditions are important in order to preserve the vitamin values and other qualities of the pasteurized milk obtained as a final product with added vitamins A and D. Otherwise, the value of vitamins and other nutritional supplements added to milk can be lost in a short time, making enrichment and other processes ineffective. It would not be a logical and productive endeavor to lose the amount of vitamins added after production because it cannot provide adequate post-production conditions in the short term (Harris, 1988: 5).

Vitamins are extremely sensitive to heat, light, humidity, chemicals and some mechanical processes. Such exposure of the final product during storage conditions can affect the stability and activity of the vitamin, causing undesirable changes as well as adverse effects on other components. Therefore, the selection of storage conditions and suitable packaging materials is of great importance (Gottlieb, 1984: 36).

Here we focus on two influencing factors. The first of these is the material in which pasteurized milk with added vitamins is packaged, and the second is the amount and duration of light rays. How important both factors are is clearly shown in the conducted research.

In this study, the results of vitamin A and D loss were used in 3% and 1.5% fat and skim pasteurized milk after exposure to sunlight, dark conditions, and fluorescent light for different periods of time. During the research, TetraPak and high-density polyethylene plastic bottles were chosen as packaging materials. The outside of Tetrapak containers is made of cardboard, and the inside is made of a thin (15 mm) aluminum layer, while polyethylene containers are made of 35 mm thick polyethylene layer.

There is no loss of Retinol in pasteurized milk under dark ambient conditions. Retinol loss occurs from exposure to sunlight for 3 hours depending on the type of packaging and the amount of oil. Plastic bottle (HDPE) causes more vitamin loss than tetrapack packaging (Collins, 1990: 70-71). The plastic bottle used is a packaging material that does not have a barrier against light and other factors, which is called a traditional polyethylene bottle. When the oil content is reduced from 3% to 1.5%, the loss of retinol in the plastic bottle is greater. This suggests that Retinol is more stable in high milk fat. Milk butter protects Retinol from sunlight to some
In Bradley’s work published in 1996, it is noted that no vitamin loss was detected in milk samples stored in plastic and cardboard containers under dark room conditions for 24, 48 and 72 hours. When the pasteurized milk in the two packaging materials was kept in sunlight for 2, 4 and 6 hours, no vitamin loss was observed in the product in the cardboard container. A loss of vitamin A between 8-15% and vitamin D between 6-11% was found in plastic bottles (Bradley, 1980: 315).

Although milk obtained from most dairies is not exposed to sunlight, in production facilities it is exposed to fluorescent radiation both during the production process and at the post-production stage, under storage conditions. As a result, since vitamins are sensitive to light, exposure to a certain intensity of fluorescent light can easily change their composition and cause significant vitamin loss in milk by disrupting the stable structure of vitamins.

In some dairies, failure to choose suitable packaging material for product packaging, illumination using more intense light sources, can reduce the vitamin content of the vitamin-enriched product to the previous vitamin values in a short period of time, or even to a lower level.

Some US studies of packaging materials and fluorescent light sources have shown up to 90% loss of vitamin A in pasteurized milk stored in polyethylene plastic bottles under fluorescent light for 24 hours. During the same period, it was recorded that the loss of vitamin D was about 2-3%. It has also been found that synthetically produced vitamins are less stable and that these vitamins are more easily lost by fluorescent light. The loss of vitamins A and D due to the effect of fluorescent light can be reduced by 80-90% as a result of covering packaging materials with various materials that block the passage of oxygen, moisture and light (Bradley, 1980: 316).

The main result of the study: The quality of dairy products is directly proportional to the quality of raw milk used as a raw material. In addition to the physical, chemical and sensory quality of the raw milk to be processed, its biological quality is also an important factor. Even if raw milk is suitable in terms of biological properties, heat treatment applications are a mandatory process in order to avoid any risk before processing. In this respect, in order to obtain a quality raw milk, milk producers and businesses should be informed and trainings should be given on the subject.

A number of basic factors should be taken into account in the process of enriching the content of milk with vitamins. These factors are technological, legal, economic or health-related factors. In addition, the storage conditions of the milk until it reaches the consumer directly affect its quality and the preservation of its vitamin values.

References:

Література: