Colostrum in technology of functional products: possibilities and opportunities

L E Glagoleva, N P Zatsepilina, A S Galimov and S V Pavlova
Voronezh State University of Engineering Technologies, Voronezh, Russia

E-mail: nataha.zatsepilina@yandex.ru

Abstract. Currently, there is great interest in the field of nutrition - colostrum (colostrum), which has extensive protective factors allowing the use of colostrum not only for newborn calves, but also for deterministic groups of the population - children, debilitated patients, the elderly. Colostrum is considered abnormal milk, since a sharp change in the physiological state of an animal at the beginning and at the end of the lactation stage is accompanied by the formation of a secret, the composition, physicochemical, organoleptic and technological properties of which differ significantly from the same indicators of normal milk. Thus, the obtained positive data indicate the possibility and prospects of using colostrum in the technology of functional products.

1. Introduction
According to the World Health Organization, 70% of human health is determined by lifestyle and nutrition. Of all its physiological needs, nutrition is the most important factor in ensuring the development and continuous renewal of all cells and tissues of the body, determines the supply of energy necessary to restore the body's energy costs both at rest and during physical activity. Absolutely all vital functions of the body are closely related to nutrition. In recent years, there has been a shortage of a number of essential nutritional components, especially negative dynamics is observed in the structure of protein nutrition. The average person's daily diet includes a significant amount of carbohydrates and sugar. At the same time, due to the sharp deterioration of the ecological situation, food began to contain an excessive amount of pesticides, radionuclides, salts of heavy metals, nitrates, etc. All these factors invariably affect the health and genetic stock of the human body.

At present, colostrum (colostrum) is of great interest in the field of nutrition, which has extensive protective factors allowing the use of colostrum not only for newborn calves, but also for deterministic groups of the population - children, debilitated patients, the elderly [1, 2]. Colostrum is a thick yellow substance that is secreted by the mammalian mammary gland within 1-2 days after the birth of offspring; colostrum contains a wide range of antibodies [3-5].

Colostrum is considered abnormal milk, since a sharp change in the physiological state of an animal at the beginning and at the end of the lactation stage is accompanied by the formation of a secret, the composition, physicochemical, organoleptic and technological properties of which differ significantly from the same indicators of normal milk. Compared to milk, colostrum contains 3 ... 5 times more proteins (60 ... 80% of which are whey proteins); immunoglobulins (IgA, IgG, IgD, IgE, IgM, of which 90% are IgA); cytokines that provide intercellular interaction in the immune system, they include interferon; almost 1.5 times more fat and minerals, but less lactose [6,7,8].
Colostrum is a natural food. It contains at least 37 immune factors and 8 growth factors, which help the body to defeat diseases and contribute to good health and longevity. The composition of colostrum is influenced by the breed and individual characteristics of cows, their age, calving season, composition and nutritional value of rations, technological parameters of animal husbandry (duration dry period, the scheme of starting and preparing for calving, etc.). Colostrum contains everything the body needs: proteins, fats, carbohydrates, minerals, vitamins, water [9-12].

Purpose of the work: to study the physicochemical and organoleptic characteristics of colostrum in order to use it in the production technology of products for various functional purposes.

2. Materials and methods

The work used a modern method of analysis, including instrumental and special chemical, organoleptic research methods. The experimental studies were carried out according to the planned experimental scheme, using various methods, techniques and approaches, allowing to obtain the most correct range of analyzes for further assessment and feasibility of using colostrum. The object of the study was colostrum 4-5 days of calving. To assess the composition and properties of the object under study, the following indicators were determined:

- Sampling was carried out in accordance with GOST 3622-68.
- Organoleptic assessment was carried out in accordance with GOST R ISO 22935-2-2011.
- Mass fraction of moisture according to GOST 3626-73 “Milk and dairy products. Methods for Determination of Moisture and Dry Substances”.

The mass fraction of protein was determined by the Kjeldahl method "GOST 23327-98" Milk and dairy products. Method for measuring the mass fraction of total nitrogen according to Kjedahl and determination of the mass fraction of protein”.

GOST 5867-90 "Milk and milk products. Methods for determining fat."

GOST 26809-86 "Milk and dairy products. Acceptance rules, sampling methods and preparation for analysis."

GOST 362-92 “Milk and dairy products. Titrimetric Methods for Determining Acidity”.

GOST 32901-2014 “Milk and dairy products. Microbiological analysis methods”.

3. Discussion and results

In the investigation, we determined the indicators of colostrum, i.e. taste (slightly salty), smell (milky), consistency (thick and sticky) and color (milky yellow). Physical and chemical indicators (table 1) and amino acid composition (table 2) were also studied.

Table 1. Physicochemical properties of colostrum.

| Parameter                          | Milk     | Colostrum |
|------------------------------------|----------|-----------|
| Titratable acidity, °T             | 19.0     | 39.6      |
| Weight fraction of dry substances, % | 13.2     | 21.7      |
| Weight fraction of fat, %          | 2.4      | 5.5       |
| Weight fraction of protein, %      | 3.3      | 13.7      |
| Weight fraction of lactose, %      | 4.3      | 2.9       |
| Viscosity, mPa·s                   | 0.0153   | 0.0251    |
| Density, kg / m³                   | 1027.0   | 1053.0    |

Table 2. Amino acid composition of colostrum.

| Amino acids | Colostrum |
|-------------|-----------|
| arginine, % | 0.2068    |
| lysine      | 0.0243    |
| tyrosine    | 0.1393    |
The analysis of the data obtained showed that colostrum contains a high amount of amino acids such as proline, tyrosine, arginine and phenylalanine.

Phenylalanine serves as a raw material for the biosynthesis of tyrosine and dioxyphenylalanine—a functional regulator of the nervous system—and has a beneficial effect on the functioning of the brain. Tyrosine is used as a raw material in the biosynthesis of vital for the body substances such as dioxyphenylalanine, norepinephrine and thyroid hormones. Arginine helps to accelerate the synthesis of growth hormone and other hormones. It actively participates in the activity of the genital organs, that is, it indirectly stimulates the release of testosterone in men, and participates in the utilization of nitrogen for the synthesis of nonessential amino acids. Proline is a nonessential amino acid and performs auxiliary GABA functions in inhibiting the central nervous system. Its important task is to preserve the biologically active substances of colostrum.

When colostrum is stored at different temperature conditions, various biochemical processes occur that change the pH and acidity. In turn, a change in pH leads to disruption of the conformation of protein molecules or their denaturation and, consequently, to the loss of their biological activity. So, it is necessary to control these indicators during colostrum storage.

Table 3 presents data on the change in the colostrum pH, depending on the temperature and shelf life. As can be seen from the data presented, storage of colostrum at a temperature of -12 °C for 28 days did not lead to a change in pH. At storage temperatures of 20 and 4 °C, the pH was considerably different. Further storage of colostrum at these temperatures led to its souring. This was apparently due to the fact that at near-zero positive temperatures, the metabolic rate of lactic acid bacteria is reduced and, therefore, the pH of colostrum decreased less rapidly than at room temperature.

The acidity of colostrum did not change during storage at low temperatures (table 4). However, during storage at positive temperatures, this indicator changed more than the pH did.

| Temperature, °C | Shelf life, day |
|----------------|----------------|
|                | 7   | 14  | 21  | 28  |
| 20             | 5.15| −   | −   | −   |
| 4              | 6.27| 5.81| −   | −   |
| −12            | 6.28| 6.29| 6.31| 6.33|
Table 4. Colostrum acidity, °T, depending on temperature and shelf life.

| Temperature, °C | Shelf life, day |
|----------------|----------------|
|                | 7              | 14                   | 21                   | 28                   |
| 20             | 94             | –                    | –                    | –                    |
| 4              | 53             | 77                   | –                    | –                    |
| −12            | 48             | 54                   | 57                   | 60                   |

4. Conclusion

Thus, the presented results allowed us to conclude that the storage of colostrum at negative temperatures for up to 28 days does not lead to adverse changes in the studied parameters. The duration of storage at positive temperatures is limited to several days.

The research selected and substantiated the following modes of the heat treatment of colostrum:

- \( t = 70\pm2 \, ^\circ C \), 10 min.
- \( t = 76\pm2 \, ^\circ C \), 4 min.
- \( t = 85\pm2 \, ^\circ C \), 1-2 min.

The optimal heat treatment mode was \( t = 70\pm2 \, ^\circ C \) for 10 minutes, since at this temperature, with constant monitoring of the alcohol test and bacterial contamination, protein coagulation was not observed.

Thus, the obtained positive data indicated the possibility and opportunity of colostrum being used in the technology of functional products.

References

[1] Vorobiev V V 2017 The state of health of Russians and the problem of the quality of food products *Agrarian Russia* 6 15-9
[2] Hoerr R and Bostwick E F 2006 A Colostrum-based products *Dairy Prost* 8 53-4
[3] Gubkin S M 1978 *Colostral immunity* (Omsk: Omsk Agricultural Institute)
[4] Rydak P A, Soldatov A P, Epshtein N A and Edel K E 1989 *Biological properties and foundations of the rational use of colostrum* (Moscow: VASKHNIL)
[5] Mosiyko V I, Zusmanovsky A G and Zvinyakovsky V G 1989 *Intensification of dairy cattle breeding* (Moscow: Agropromizdat)
[6] Krmatsov A G, Brykalov A B and Pilipenko N Yu 2012 Whey drinks with herbal ingredients *Diary industry* 7 64-6
[7] Gorlov I F, Slozhenkina M I, Skachkov D A, Voznyak E A and Mosolova N I 2019 *Food industry* 11 20-4
[8] Kourkoutas Y, Xolias V, Kallis M, Bezirtzoglou E and Kanellaki M 2005 *Process Biochemistry* 40(1) 411-6
[9] Lopez H W, Leenhardt F and Coudray C 2002 Minerals and phytic acid interactions: is it a real problem for human nutrition? *International Journal of Food Science and Technology* 37 727-39
[10] Vasyukova A T, Bunevich D K and Penukhina O A 2020 Application of food additives from vegetable raw materials in the production of cottage cheese desserts with increased nutritional value In: *Quality and environmental safety of food products and industries: materials of an international scientific-practical conference with elements of a scientific school for youth* 25-9
[11] Glagoleva L E et al. 2021 *IOP Conf. Ser.: Earth Environ. Sci.* 640 032048
[12] Serba E M, Rimareva L V, Sokolova E N, Borshcheva Yu A, Kurbatova E I, Volkova G, Pogorzhekskaya N S and Martynenko N N 2017 *Biotechnological bases of directed conversion of agricultural raw materials and secondary biological resources for obtaining food ingredients, functional food and feed* (Moscow: Biblio-Globus)