The quality of milk of goats of Saanen, Alpine and Nubian breeds

A S Shuvarikov, O N Pastukh, E V Zhukova and O A Zheltova

Moscow Agricultural Academy named after K A Timiryazev, 48, Timiryazevskaya st., Moscow, 127434, Russia

E-mail: tppj@rgau-msha.ru

Abstract. Dairy goat breeding is becoming more widespread, both in the world and on the territory of the Russian Federation, as goat milk is recognized as an easily digestible dietary product with high nutritional and biological value. The most common goat breeds in Russia which are suitable for the industrial milk production are Saanen, Alpine, and Nubian breeds. The studies were carried out in the laboratory of the department of processing technologies and storage of animal origin produce FSBEI HE RGAU - Moscow Agricultural Academy named after K. A. Timiryazev and in the laboratory of technological control VNIMI. The highest milk yield for 305 days of lactation was found in goats of the Saanen breed, which significantly exceeded the milk yield of alpine goats. The mass fraction of fat in the milk of goats of the Nubian breed was the highest, in the milk of goats of the Alpine breed and significantly exceeded this indicator in the milk of goats of the Saanen breed. The highest protein content in milk was found in goats of the Alpine breed than in goats of the Saanen and Nubian breeds. At the same time, when evaluating goat milk, it is necessary to take into account its differences from the established parameters for cow milk: a higher content of somatic cells; low freezing point; inconsistency in the alcohol sample to the thermal stability groups of the cow.

1. Introduction

In natural and organic food, demand for goat milk and products from this type of milk is growing with the rapt interest. High-tech food products based on goat milk, cheeses and other protein products can provide a rational, wholesome and healthy diet for the population [1,2].

In the world, goat milk is widely used for the production of cheeses, yogurt and other dairy products. Taking into account the physicochemical properties and some other parameters of goat’s milk, it is considered more acceptable than cow’s for the production of baby food, since the proteins and fats of goat’s milk are easily absorbed in the human body due to the structure of the molecules. Of particular interest are the hypoallergenic and biological properties of goat milk [3-5]. However, the technology of goat milk products requires serious theoretical and practical development.

One of the most common goat breeds in Russia’s dairy goat breeding is Saanen, along with alpine and Nubian breeds used in some farms. The goats of these breeds vary significantly in terms of productivity and milk composition, so there is a need for a comprehensive assessment of the milk of goats of these breeds for the most effective and targeted use [4,6].
2. The purpose of the study
Assessment of milk productivity, physico-chemical composition and technological properties of milk of goats of Saanen, Alpine and Nubian breeds.

3. The object of study
The object of research was the milk of goats of the Saanen, Alpine and Nubian breeds contained on the basis of the SPK Krasnaya Niva, Mytishchi district, Moscow region.

4. Materials and methods
The studies were carried out in the laboratory of the department of processing technologies and storage of animal origin produce, and the laboratory of technological control VNIMI. To conduct research on the basis of SPK Krasnaya Niva, Mytishchi district, Moscow Region, 3 groups of goats of the third lactation (10 goals in each group) of Saanen (1 group), Alpine (2 group) and Nubian (3 group) breeds were formed. All animals were at the end of the first - beginning of the second month of lactation, the conditions for feeding and keeping goats were the same.

Milk productivity was determined by the results of monthly control milking, milk quality indicators were analyzed in individual samples and in collected milk by animal groups, milk samples were taken at 1-2, 4-5 and 7-8 months of goat lactation.

5. Discussion of the results
5.1 Goat milk production
Analysis of the milk productivity of goats of different breeds indicated that the goats of the Saanen breed were superior to their herdmate of the Alpine and Nubian breeds in milk yield for 305 days of lactation and had higher daily milk yields compared to them (table 1). At the same time, a significant advantage in the milk yield of goats of the Saanen breed was only in comparison with animals of the Alpine breed (P<0,05).

| Indicator                          | Goat breed         |
|------------------------------------|--------------------|
| Milk yield for 305 days of lactation, kg | 630,14 ±43,64*1-2 | 554,17 ±30,86 | 608,70 ±83,64 |
| Milk fat, kg                       | 24,33 ±1,69        | 23,38 ±1,37  | 26,96 ±3,79*3-2 |
| Milk protein, kg                   | 21,37 ±0,91        | 19,95 ±0,03  | 22,21 ±3,33    |
| The average daily milk yield, kg   | 2,15 ±0,13*1-2     | 1,76 ±0,09   | 1,84±0,20      |
| The maximum daily milk yield, kg   | 2,80 ±0,10         | 2,63 ±0,14   | 3,08±0,32      |

Note: * - P<0,05; 1-2 – ratio of indicators between groups (1 to 2 etc.)

In goats of the Nubian breed, in comparison with goats of the Alpine and Saanen breeds, superior yield of milk fat over the lactation period was established, although a significant difference was noted only in relation to the indicator of goats of the Alpine breed. Fluctuations in the protein content in the milk of experimental animals ranged from 2.05 to 4.38%. Alpine animals with the highest protein content in milk, in comparison with peers of other breeds, had the lowest yield for lactation, which was associated with the milk yield of these animals, which was slightly lower than the milk yield of goats of Saanen and Nubian breeds.

5.2 Physico-chemical characteristics of goat milk
The dry matter content in the goat’s bulk milk ranged from 11.95 to 13.00%, and nonfat milk solids
(SOMO) content ranged from 8.41 to 8.72% (table 2). At the same time, the highest solids content of milk was in goats of the Nubian breed, due to the fact that a higher level in the milk of these animals nonfat milk solids (SOMO), fat and lactose, is compared to other groups of goats.

Table 2. Quality indicators of goat milk

| Indicator                | saanen         | Goat breed | nubian         |
|--------------------------|----------------|------------|----------------|
| The milk contains, %:    |                |            |                |
| - dry matter             | 12,48±0,48     | 12,52±0,46 | 13,00±0,43     |
| - dry skim milk residue  | 8,41±0,20      | 8,53±0,25  | 8,72±0,26      |
| - fat                    | 4,02±0,05      | 4,22±0,07  | 4,30±0,03*     |
| - protein                | 3,55±0,03      | 3,72±0,10* | 3,61±0,07      |
| - lactose                | 4,34±0,11      | 4,41±0,14  | 4,51±0,12      |
| - total nitrogen         | 0,58±0,07      | 0,64±0,08  | 0,59±0,08      |
| - non-protein nitrogen   | 0,047±0,006    | 0,049±0,012| 0,030±0,008    |
| Freezing point, minus °C | 0,505±0,012    | 0,517±0,002| 0,517±0,008    |
| Density, g/cm³           | 1,028±1,02     | 1,028±1,02 | 1,028±1,02     |
| Titratable acidity, °T   | 18,67±2,16     | 18,67±2,16 | 18,67±2,16     |
| Somatic content, thousand/cm³ | 883,33±79,85 | 677,33±95,38 | 831,00±71,42 |

According to the content of total and non-protein nitrogen, the highest rates were noted in the milk of goats of the Alpine breed.

The minimum value of the freezing point of milk is set for goats of the Saanen breed. In the analyzed goat breeds, the milk density was 1.028-1.029g/cm³. The titratable acidity of milk of goats of the Nubian breed was the highest in comparison with the indicators of milk of goats of other breeds.

The content of somatic cells in goat’s milk was more than 500 thousand/cm³, which exceeds the indicator adopted for cow’s milk. At the same time, in the milk of animals of alpine breed the content of somatic cells was lower than in milk of goats of other breeds.

5.3 Characteristics of goat milk proteins

For the purpose of analyzing the quantitative content of milk proteins, it was found that goats milk of the most numerous livestock - Saanen breed contains on average 3.55% of total protein, 2.77% of casein and 0.78% of whey proteins (table 3).

Table 3. Characteristics of the protein phase of goat milk

| Indicator                                      | saanen         | Goat breed | nubian         |
|------------------------------------------------|----------------|------------|----------------|
| Characteristics of milk proteins               |                |            |                |
| Total protein, %                              | 3,55±0,03      | 3,72±0,10* | 3,61±0,07      |
| including: - casein                           | 2,77±0,25      | 2,91±0,18  | 2,84±0,19      |
| - whey proteins                               | 0,78±0,07      | 0,81±0,05  | 0,77±0,06      |
| Dispersion of casein micelles of milk         |                |            |                |
| - the average mass of casein micelles, million units pier masses | 130,69±3,82 | 131,22±7,54 | 154,47±7,16* |
| - the average diameter of casein micelles, nm  | 68,56±1,01     | 68,65±1,56 | 72,57±1,09     |
| Rennet milk coagulability, min.               | 11,77±3,31     | 11,00±2,04 | 8,03±1,41      |
By the content of all protein substances in milk, goat of the Saanen, as well as Nubian breeds were inferior to goats of the Alpine breed. In alpine goats, the excess in protein was significant in comparison with the protein content in the milk of goats of the Saanen breed (P <0.05).

In the milk of goats of the Nubian breed, the average weight and size of casein micelles were the largest and amounted to 154.47 million units, respectively, molar mass and 72.57 nm with a significant difference in the size of casein micelles with milk of goats of the Saanen breed. Among the experimental animals, the fastest coagulation of milk with rennet was in goats of the Nubian breed.

The total content of essential amino acids in the milk of goats of the experimental breeds ranged from 1238.33 mg/100 g to 1285.67 mg/100 g (table 4). At the same time, the content of essential amino acids in the milk of goats of the Alpine breed exceeded that of the milk of animals of two other breeds. The milk of goats of the Alpine breed also had a slightly higher content of individual essential amino acids - lysine, tryptophan, methionine, than in the milk of animals of the Saanen and Nubian breeds. However, the established differences in the content of essential amino acids in milk between goat breeds were not statistically significant.

### Table 4. Amino acid composition of goat milk

| Indicator | saanen | Goat breed | nubian |
|-----------|--------|------------|--------|
| The content of essential amino acids, mg/100g | 1263.33±24.91 | 1285.67±14.53 | 1253.50±22.77 |
| including: - lysine | 240.67±12.36 | 254.67±13.39 | 252.00±14.35 |
| - tryptophan | 40.07±3.64 | 44.67±2.16 | 38.90±3.68 |
| - methionine | 71.17±0.93 | 72.00±3.94 | 71.33±0.82 |

5.4 Characteristics of goat milk fat

The indicators of the number and average diameter of fat globules in the milk of goats of the Saanen breed were higher than the similar indicators in the milk of goats of the Alpine and Nubian breeds (table 5). Among the compared goat breeds, the highest content of small fat globules (up to 2.5 μm) was noted in the milk of goats of the Nubian breed (28.35% versus 23.96 and 22.25% in the milk of goats of the Saanen and Alpine breeds, respectively).

### Table 5. Fat phase characteristics for goat milk

| Indicator | saanen | Goat breed | nubian |
|-----------|--------|------------|--------|
| Dispersion of fat globules | 5.12±0.48 | 4.19±0.69 | 3.82±0.36 |
| The number of fat globules in 1 ml of milk, billion | 4.49±0.89 | 4.41±0.59 | 4.15±0.94 |
| The distribution of fat globules in size | | | |
| - up to 2.5 microns | 23.96±2.30 | 22.25±2.40 | 28.35±4.40 |
| - from 2.5 to 5.0 microns | 34.37±5.79 | 34.20±4.99 | 34.54±3.08 |
| - from 5.0 to 7.5 microns | 17.19±2.39 | 19.88±3.82 | 13.68±2.14 |
| - more than 7.5 microns | 24.45±5.72 | 23.87±6.17 | 23.42±2.63 |

5.5 Vitamin composition of goat milk

The amount of vitamin A in goat milk was 0.014-0.016 mg/100g (table 6). Data on the content of vitamin A in the milk of goats of different breeds demonstrated the previously obtained information by other authors about the level of vitamin A in goat milk. The reproduced difference in the content of
vitamin A in the milk of goats of different groups is unreliable. The content of vitamin C in milk of goats of the Nubian breed was the highest and significantly exceeded the content of vitamin C in milk of animals of the Saanen breed.

Table 6. Vitamin nutrition of goat milk

| Indicator | Goat breed | saanen | alpine | nubian |
|-----------|------------|--------|--------|--------|
| vitamin A |            | 0,015±0,004 | 0,016±0,004 | 0,014±0,003 |
| vitamin C |            | 1,51±0,29 | 1,53±0,25 | 1,68±0,32 |

5.6 Mineral composition of goat milk

In milk of goats of the Nubian breed, compared with goats of the Saanen breed, the level of macrocells such as calcium, phosphorus and zinc was higher with varying degrees of reliance, and the level of potassium and sodium relative to animals of the Alpine breed (table 7). The highest content of trace elements - iron and zinc is found in milk of goats of the Alpine breed.

Table 7. Mineral composition of goat milk

| Indicator          | Goat breed | saanen          | alpine          | nubian          |
|-------------------|------------|-----------------|-----------------|-----------------|
| Calcium mg/100g   |            | 204,34±6,85     | 214,53±5,91     | 228,95±1,92*** |
| Phosphorus, mg/100g |          | 90,26±1,01      | 84,40±5,66      | 99,30±2,74***   |
| Potassium, mg/100g|            | 170,63±1,73***  | 152,11±5,03     | 174,61±1,15***  |
| Sodium, mg/100g   |            | 54,03±3,33      | 48,67±2,72      | 56,96±1,16***   |
| Iron, mcg/100g    |            | 59,26±9,32      | 75,89±6,48      | 54,65±0,23      |
| Copper, mcg/100g  |            | 54,84±3,24      | 43,72±3,24      | 53,55±1,15      |
| Manganese, mcg/100g |        | 33,35±2,65      | 30,39±1,93      | 30,58±3,78      |
| Magnesium, mcg/100g |         | 11,83±0,26      | 12,51±0,36      | 12,03±0,27      |
| Zinc, mcg/100g    |            | 364,07±1,34     | 501,55±55,10*** | 443,19±4,15***  |

5.7 Heat resistant goat milk

When determining the thermal stability of goat’s milk from an alcohol test, it was found that the coagulation of goat’s proteins was occurred under the influence of the lowest (provided for cow’s milk) - 68% alcohol concentration, while the goat’s milk withstood high-temperature exposure in an ultra-thermostat at 130°C for 30-37 min and may be sterilized during processing (table 8). Among the samples of milk of goats of different breeds that we studied, the milk of goats of the Saanen breed withstood the longest high-temperature exposure in an ultra-thermostat.

Table 8. Heat resistant of goat milk

| Indicator | Goat breed | saanen | alpine | nubian |
|-----------|------------|--------|--------|--------|
| Alcohol test, volume fraction of ethyl alcohol,% | does not withstand 68% concentration |                |        |
| Thermal test, using an ultra-thermostat, min. | 37,50±22,06 | 30,87±27,67 | 29,87±18,30 |

6. Conclusions

The highest milk yield for 305 days of lactation was found in goats of the Saanen breed (630 kg), which significantly exceeded the milk yield of alpine goats (554 kg).
The fat content in milk of goats of the Nubian breed was the highest (4.30%) and significantly exceeded (P <0.05) the percentage of fat in milk of goats of the Saanen breed (4.02%). The amount of fat globules in the milk of goats of the Saanen breed was 5.12 billion / ml, which with a significant difference (P <0.05) exceeded the indicator of milk of goats of the Nubian breed - 3.82 billion / ml. The largest number of small fat globules (desirable for drinking milk) was found in the milk of goats of the Nubian breed. The largest percentage of large fat globules that positively affect the efficiency of milk separation and yield is found in the milk of goats of the Saanen breed.

The highest protein content in milk was found in goats of the Alpine breed - 3.72%, with a protein level of 3.75% for goats of the Saanen breed and 3.61% for the Nubian breed. The average weight and diameter of casein micelles of goat milk of Nubian breed exceeded the corresponding indicators of goat milk of Saanen and Alpine breeds. At the same time, the goats of the Nubian breed had a significant excess of the mass of casein micelles in comparison with the mass of casein micelles of milk of goats of the Saanen breed (P <0.05).

The freezing point of goat milk does not reach the minimum value established for cow’s milk (-0.52 °C), which must be taken into account when accepting and evaluating raw goat's milk.

The content of somatic cells in goat’s milk was high (677 - 883 thousand/cm$^3$) compared to the standard established for cow’s milk, but did not exceed the level of somatic cells established in the technical conditions of a number of goat farms for goat milk of the highest and first grades (1000 thousand/cm$^3$).

The content of vitamin C in milk of goats of the Nubian breed was the highest, while significantly higher than the content of vitamin C in milk of animals of the Saanen breed.

Compared to milk of goats from the Saanen breed, the content of calcium, phosphorus and zinc was higher in milk of goats of Nubian breed, compared with milk of animals of alpine breed, and the level of potassium and sodium was higher with varying degrees of reliance.

In examination of thermal stability, according to the alcohol test generally accepted for cow’s milk, it does not withstand the influence of the lowest alcohol concentration of 68%, but is resistant to high-temperature heating in an ultra-thermostat (at 130 °C for 20-30 minutes) and can be pasteurized and sterilized during processing.

When evaluating goat milk, one should take into account its differences from the established parameters for cow milk: a higher content of somatic cells; low freezing point; inconsistency in the alcohol sample to the heat resistance groups of cow’s milk.

References
[1] Poymanov V V, Grishanova D S and Antipov S T 2018 Research on the processes of freezing and vacuum freeze-drying of bacterial concentrates for the dairy industry Bulletin of VGUIT 80 (4) 19-24
[2] Ivkova I A, Scriabin O V, Ryabkova D S, Diner Yu A and Petrova E I 2018 Development of technology and research on the quality of canned milk for regions with limited resources of natural dairy raw materials Bulletin of VGUIT 80 (3) 254-258
[3] Gorlov I F, Mosolova N I and Korotkova A A 2012 New in the production of functional products from goat milk Bulletin of the Russian Academy of Agricultural Sciences 4 16-18
[4] Brunchugin V V, Shuvarikov A S and Pastukh O N 2011 Dairy productivity and some quality indicators of milk of goats of the Saanen, Alpine and Nubian breeds Sheep, goats, wool 4 30 - 33
[5] Simonenko S V, Felik S V, Simonenko E S, Antipova T A, Shuvarikov A S and Pastukh O N 2017 Goat milk is a valuable raw material for the production of children's dairy products Sheep, goats, wool 4 33 - 35
[6] Gogaev O K, Demurova A R and Morgoeva D G 2015 Technological qualities of goat milk depending on the age of the goats and the season of the year 2015 Livestock in the South of Russia 5 (7) 12-15