Quality of colostrum in dairy and dual purpose cow breeds depending on the duration of calving cycle periods

S V Karamayev¹, L N Bakayeva², A S Karamayeva¹ and N V Soboleva²

¹Federal State Budgetary Educational Establishment of Higher Education Samara State Agricultural Academy, 2, Uchebnaya st., Ust-Kinelsky, Samara region, 446442, Russia
²Federal State Budgetary Educational Establishment of Higher Education Orenburg state agricultural university, 18, Chelyuskintsev st., Orenburg, Orenburg region, 460795, Russia

E-mail: karamaevsv@mail.ru

Abstract. Correlation of quality of colostrum in dairy and dual-purpose cow breeds and duration of calving cycle periods has been examined. It was established that the highest content of immunoglobulins in colostrum of cows of the Bestuzhev and the Russian Black Pied breeds was noticed with the duration of a service period of up to 60 days, in colostrum of cows of the Holstein and the Ayrshire breeds – 61-80 days. Furthermore, the content of immunoglobulins raises by 26.0% for the Bestuzhev breed, by 27.7% for the Russian Black Pied breed, by 16.7% for the Holstein breed and by 17.5% for the Ayrshire breed with the extension of gestation period from 270 to 290 days. A trend towards reduction of content of immunoglobulins with the extension of lactation period was noted. The highest content of immunoglobulins was in colostrum of cows of the Bestuzhev breed (102.7 g/l) that excelled their herdmates of the Russian Black Pied breed by 51.5%, of the Holstein breed – by 71.7% and of the Ayrshire breed – by 11.9%. Colostrum of cows without dry period was considered unsuitable for feeding calves, regardless of the breed. The highest content of immunoglobulins in the first yield colostrum was typical of cows of the Russian Black Pied, the Holstein and the Ayrshire breeds with the duration of the dry period of 61-70 days, and for the Bestuzhev breed - with the duration of the dry period of 51-60 days.

1. Introduction
One of the most important stages of raising the replacements is the period from birth until the age of 6 months, when the immunity is being formed in the body and the basics of genetic productivity of animals are being established. Its realization in an adult stage is largely predicated upon the incidence of disease in calves, proportionally with the severity and duration of the disease associated with the level of immunity and resistance of the body [1, 2].

When analyzing the reasons of diseases and heavy mortality among newborn calves, the number of researchers came to the conclusion that the selection of cattle towards the increase of milk productivity leads to certain changes in biochemical and immune status of the body. This, in its turn, affects the quality of offspring, its viability and some indicators of cows’ reproductive function. With extensive use of the Holstein breed in Russian dairy breeding, the problem of herd replacement and the quality
of raising replacements is becoming more and more important each year and requires new solutions [3, 4].

Duration of a calving interval is defined as duration of a service period and gestation, and consists of two physiological stages – lactation, when a cow produces milk, and a dry period, when production of milk stops and regeneration of the secretory epithelium of the glandular tissue of udder occurs and the body prepares for calving and new lactation. It is essential to know what impact the intensity of all organs’ work during lactation has on formation of a calf and colostrum quality, especially on its first portion, and to what extent those organs can recover before the next calving [5].

Therefore, the main research task was to establish the impact of duration of the main periods of calving cycle in dairy and dual-purpose cow breeds on the quality of the first yield colostrum.

2. Material and research methods

Scientific and household experiment was carried out on the basis of the modern milk production complexes of the Samara and Orenburg regions. Cows of four dairy breeds served as the object of the research. 10 days prior to the third calving in October, four groups of animals were formed, with 50 heads in each: I – the Bestuzhev breed, II – the Russian Black Pied breed, III – the Holstein breed and IV – the Ayrshire breed.

The impact of duration of different physiological periods of a cows’ calving cycle on the quality of the first yield colostrum after calving has been examined. Average samples of colostrum were taken prior to the first feeding of a calf. The content of immunoglobulins in colostrum was measured by digital refractometer “PAL-Coloctrum” in R&D animal breeding laboratory under the jurisdiction of Federal State Budgetary Educational Institution of Higher Education Samara State Agricultural Academy.

3. Research results

Duration of a service period defines the easiness of calving, animal’s health and its readiness for next fertilization. Duration of a calving cycle and current lactation depends on the duration of a service period. While duration of cow’s gestation is defined by its biological characteristics and the duration of a dry period – by technological procedure, the duration of a service period fully depends on the health condition and the intensity of body’s work resulting from the intensity of lactogenesis (table 1).

| Duration of a service period, days | Breed           | Russian Black Pied | Holstein | Ayrshire |
|----------------------------------|-----------------|--------------------|----------|----------|
| Up to 60                         | 101.9±0.57      | 66.4±0.39          | -        | 95.1±0.42|
| 61-80                            | 100.7±0.68      | 65.9±0.46          | 59.3±0.79| 94.7±0.59|
| 81-100                           | 98.0±0.46       | 65.3±0.51          | 58.6±0.67| 90.2±0.74|
| 101-120                          | 94.9±0.72       | 62.5±0.64          | 55.9±0.81| 86.6±0.66|
| 121-140                          | 89.3±0.64       | 58.1±0.77          | 54.5±0.73| 80.3±0.56|
| 141-160                          | 84.7±0.69       | 54.3±0.80          | 52.4±0.76| 71.5±0.63|
| More than 160                    | 76.8±0.60       | 50.8±0.65          | 48.9±0.58| 71.5±0.63|

It is established that the duration of a service period and the content of immunoglobulins in colostrum after another calving have well-defined negative correlation dependence. The highest content of immunoglobulins in colostrum of cows of the Bestuzhev and the Russian Black Pied breeds was noticed with the duration of a service period of up to 60 days, in colostrum of cows of the Holstein and the Ayrshire breeds – 61-80 days. Furthermore, the content of immunoglobulins in colostrum of cows of the Bestuzhev breed was 35.5 g/l higher than that in colostrum of cows of the
Russian Black Pied breed (53.5%; P<0.001), 42/6 g/l higher than that in the Holstein breed (71.8%; P<0.001), and 6.8 g/l higher than that in the Ayrshire breed (7.2%; P<0.001).

An extended service period of current lactation has negative impact on the quality of the first yield colostrum of the next lactation. With the extension of a service period till 100 days, the content of immunoglobulins in colostrum falls by 3.9 g/l (3.8%; P<0.001) in the Bestuzhev breed, by 1.1 g/l (1.7%) in the Russian Black Pied breed, by 0.7 g/l (1.2%) in the Holstein breed, and by 0.4 g/l (0.4%) in the Ayrshire breed. Further extension of a service period from 120 days to 160 days and more leads to even more significant changes in the colostrum content. The content of immunoglobulins falls by 21.2 g/l (21.6%; P<0.001) in the Bestuzhev breed, by 14.5 g/l (22.2%; P<0.001) in the Russian Black Pied breed, by 9.7 g/l (16.6%; P<0.001) in the Holstein breed, and by 23.2 g/l (24.5%; P<0.001) in the Ayrshire breed. It should be noted that for breeds with the high content of immunoglobulins in colostrum (the Bestuzhev, the Ayrshire) it is typical that reduction of immunoglobulins concentration goes more intensively with the extension of a service period than, for example, for the Holstein breed, whose content of immunoglobulins is below physiological standard. Apparently, the body of the Holstein cow uses all its reserves to the detriment of its health and viability to ensure protection against disease for future offspring.

There are some research results [6, 7] showing that the immune status of colostrum is significantly higher when male calves are delivered. It is a well-known fact that duration of pregnancy with male calves is longer than with female calves. That is why, most probably, the content of immunoglobulins against disease for future offspring.

Research results showed that the content of immunoglobulins in first yield colostrum increases with the extension of gestation duration from the minimum value (up to 270 days) to 286-290 days. Differences are the following: for the Bestuzhev breed – 21.1 g/l (26.0%; P<0.001), for the Russian Black Pied breed – 14.4 g/l (27.7%; P<0.001), for the Holstein breed – 8.4 g/l (16.7%; P<0.001), for the Ayrshire breed – 13.9 g/l (17.5%; P<0.001). Extension of cows’ gestation to more than 290 days leads to reduction of the immunoglobulins content in first yield colostrum regardless of the breed.

Gender distribution of newborn calves showed that with the gestation duration below the average value, there are more female calves delivered, while with the gestation period of more than 285 days, mainly male calves are delivered (table 3).

By and large, the principle of balance in nature remained stable in experimental groups. In particular, for the cows with gestation period of up to 285 days, the proportion of female calves in the Bestuzhev breed was 59.5%, in the Russian Black Pied breed – 58.3%, for the Holstein breed – 62.9%, in the Ayrshire breed – 61.8%. Among the offspring of cows with gestation period of more than 285 days, male calves prevailed, 87.5; 78.6; 80.0; 75.0% for breeds respectively.

During the whole calving cycle, the maximum pressure on the cow’s body is placed during lactation period. It is common knowledge that highly-productive animals usually have problems with
calving, insemination and drying off, which leads to significant extension of service and lactation periods (table 4).

**Table 3. Ratio of male and female calves delivered by cows with different gestation duration**

| Gestation period, days | Breed                   | ♂   | ♀   | ♂   | ♀   | ♂   | ♀   | ♂   | ♀   | ♂   | ♀   |
|------------------------|-------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Up to 270              | Bestuzhev               | 2   | 3   | 1   | 2   | -   | -   | -   | -   | -   | -   |
| 271-275                | Russian Pied            | 2   | 3   | 2   | 2   | -   | 3   | 1   | 3   | -   | -   |
| 276-280                | Russian Black           | 6   | 9   | 4   | 5   | 3   | 8   | 4   | 5   | -   | -   |
| 281-285                | Holstein                | 9   | 10  | 8   | 12  | 10  | 11  | 8   | 13  | -   | -   |
| 286-290                | Ayrshire                | 4   | 1   | 8   | 3   | 8   | 3   | 9   | 4   | -   | -   |
| 291-295                |                         | 3   | -   | 3   | -   | 4   | -   | 3   | -   | -   | -   |

**Table 4. Impact of previous lactation duration on the content of immunoglobulins in first yield colostrum for animals of different breeds (II lactation), g/l**

| Lactation duration, days | Breed                   | Bestuzhev | Russian Pied | Russian Black | Holstein | Ayrshire |
|--------------------------|-------------------------|-----------|-------------|--------------|----------|---------|
| Up to 270                |                         | 95.4±0.41 | 64.3±0.44   | -            | 91.8±0.49|         |
| 271-305                  |                         | 102.7±0.65| 67.8±0.53   | 59.8±0.56    | 89.5±0.58|         |
| 306-330                  |                         | 100.5±0.72| 66.1±0.69   | 58.1±0.83    | 85.8±0.62|         |
| 331-360                  |                         | 93.8±0.68 | 65.6±0.76   | 56.7±0.77    | 78.1±0.74|         |
| 361-390                  |                         | 84.9±0.59 | 61.7±0.88   | 48.4±0.85    | 69.5±0.67|         |
| 391-420                  |                         | -         | 57.2±0.72   | 41.5±0.73    |          |         |
| More than 420            |                         | -         | 51.4±0.84   | 34.2±0.56    | 61.7±0.59|         |

The lactation period that is shorter than 270 days is considered inadequate. During our experiment, no such animals have been indicated in groups of import cows. In groups of the Bestuzhev and the Russian Black Pied breeds their proportion amounted to 10 and 16% respectively. The ability to dry off naturally when the conditions are unfavorable is typical of the Bestuzhev breed. At the same time, there were no animals in the group with the lactation period of more than 390 days.

A steady trend towards decreasing the content of immunoglobulins with the extension of the lactation period was noted. The highest content of immunoglobulins in colostrum was noted with the lactation duration of 271-305 days. The highest content of immunoglobulins was in colostrum of cows of the Bestuzhev breed (102.7 g/l) that excelled their herdmates of the Russian Black Pied breed by 34.9 g/l (51.5%; P<0.001), of the Holstein breed – by 42.9 g/l (71.7%; P<0.001), and of the Ayrshire breed – by 10.9 g/l (11.9%; P<0.001). Difference in the content of immunoglobulin between the animals with the longest and the shortest lactation in the Bestuzhev breed group was 17.8 g/l (21.0%; P<0.001), in the Russian Black Pied breed group – 16.4 g/l (31.9%; P<0.001), in the Holstein breed group – 25.6 g/l (74.8%; P<0.001), and in the Ayrshire breed group – 30.1 g/l (48.8%; P<0.001).

Among all periods of the calving cycle, a dry period has the greatest impact on the growth and development of fetus, quality of the next lactation and the product generated during it, and easiness of calving. The question about the duration of a dry period is still arguable. Technology provides for the standard duration of a dry period of 45-60 days. However, some authors claim that for cows with high yield (more than 5 thousand kg of milk), it is necessary to extend such period to 70 and even 75 days, because 60 days is not enough for an animal’s body to restore inner reserves. On the other hand, all too often there are violations of the technology stemming from the difficulty to dry off the highly-productive cows, which leads, quite contrary, to significant reduction of a dry period (table 5).
Table 5. The content of immunoglobulins in first yield colostrum with different duration of cows’ dry period, g/l (X±Sx)

| Dry period, days | Breed          | Bestuzhev | Russian Black Pied | Holstein | Ayrshire |
|------------------|----------------|-----------|--------------------|----------|----------|
|                  |                |           |                    |          |          |
| Without dry      |                | 43.5±0.38 | 38.9±0.33          | 29.1±0.56| 35.4±0.64|
| Up to 10         |                | 58.6±0.51 | 51.0±0.46          | 35.9±0.69| 49.2±0.52|
| 11-20            |                | 70.2±0.57 | 56.7±0.48          | 38.4±0.82| 59.6±0.69|
| 21-30            |                | 82.4±0.53 | 59.1±0.62          | 44.8±0.74| 65.3±0.78|
| 31-40            |                | 89.7±0.68 | 63.2±0.54          | 51.3±0.79| 76.5±0.64|
| 41-50            |                | 98.6±0.62 | 64.6±0.49          | 56.5±0.58| 85.3±0.67|
| 51-60            |                | 103.1±0.74| 65.9±0.45          | 60.3±0.53| 89.6±0.69|
| 61-70            |                | 102.6±0.59| 66.7±0.56          | 63.4±0.67| 90.8±0.53|

On the basis of a simulated situation, all groups have been divided into 8 sub-groups in accordance with the duration of a dry period. It was established that with the extension of a dry period, the content of immunoglobulins in cows’ first yield colostrum increases. Colostrum of cows without a dry period was considered unsuitable for feeding calves, regardless of a breed. Fully valid colostrum was obtained from the cows of the Bestuzhev breed with the duration of a dry period of 11 days and more, from the cows of the Russian Black Pied breed – 31 days, the cows of the Holstein breed – 51 days, the cows of Ayrshire breed – 21 days. By extending a dry period from 10 to 50 days, it was possible to increase the content of immunoglobulins in colostrum by 40.0 g/l (68.3%; P<0.001), 13.6 g/l (26.7%; P<0.001), 20.6 g/l (57.4%; P<0.001), 36.1 g/l (73.4%; P<0.001) for each breed respectively. Thus, the cows from the Ayrshire and the Bestuzhev groups response to the extension of a dry period more intensively, while the cows from the Russian Black Pied and the Holstein groups response less intensively.

The highest content of immunoglobulins in the first yield colostrum was noticed for the cows of the Russian Black Pied, the Holstein and the Ayrshire breeds with the duration of a dry period of 61-70 days, and for the Bestuzhev breed – 51-60 days. Extension of a dry period for the Bestuzhev breed to more than 60 days resulted in reduction of the content of immunoglobulins by 0.5 g/l (0.5%), which is, probably, due to individual characteristics of cows in this group. Cows of the Bestuzhev breed excelled their herdmates in terms of maximum content of immunoglobulins by 36.4 g/l (54.6%; P<0.001) in comparison with the Russian Black Pied breed, by 39.7 g/l (62.6%; P<0.001) in comparison with the Holstein breed, and by 12.3 g/l (13.5%; P<0.001) in comparison with the Ayrshire breed.

4. Conclusion
The authors have established correlation between the quality of first yield colostrum and the duration of calving cycle periods for cows’ breeds under research. The highest content of immunoglobulins in colostrum was noticed with the duration of a service period of 60-80 days, gestation duration of 286-290 days, duration of previous lactation of 271-305 days, duration of a dry period of 61-70 days. Moreover, the highest content of immunoglobulins was notice in colostrum of the cows of the Bestuzhev breed (103.1 g/l), and the lowest content (63.4 g/l) was noticed in colostrum of cows of the Holstein breed.

References
[1] Akers R M 2002 Lactation and the mammary gland (Iowa State Press, Blackwell Publishing Company)
[2] Pritchett L C, Gay C C, Besser T E and Hancock D D 1991 Management and production factors influencing immunoglobulin G concentration in colostrums from Holstein cows *J. Dairy Sci.* 74 2336

[3] Zarcula S, Cemescu H, Micru C, Tulcan C, Morvay A, Baul S and Popovici D 2010 Influence of breed, parity and food intake on chemical composition of first colostrum in cow *Anim. Sci. Biotechn.* 43(1) 154-157

[4] Liashengko V V and Sitnikova I V 2013 Dairy efficiency and quality of milk golshtinskikh of cows firstcalf heifers of different selection *Zootechnics* 9 18-19

[5] Fayzrakhmanov D I, Nurtdinov M G, Khayrullin A N et al. 2007 *The organization of dairy cattle breeding on the basis of technological innovations* (Kazan: Publishing house of the Kazan state university)

[6] Shtankhefel I 2007 The first days – solve everything *New agricultural industry* 2 75-78

[7] Hesecke D 1991 Metabolische Litungagrenzen bei kuhen (Berlin : Medizin) 531-535

[8] Quigley J D and Drewry J J 1998 Nutrient and immunity transfer from cow to calf pre- and postcalving *J. Dairy Sci.* 81(10) 2779-2790

[9] Quigley J D 2010 *Passive immunity in newborn calves*, available at: http://www.weds.ca

[10] Akers R M 2006 Major advances associated with hormone and growth factor regulation of mammary growth and lactation in dairy cows *J. Dairy Sci.* 89(4) 1222-1234

[11] Alois Zoge 1997 Uber die Beeinflussung der individuellen Disposition zu Infektionskrankheiten durch Warmentzungang *I. Ab-handlung, Archiv f. Hygiene* 28 344-396

[12] Georgiev I P 2008 Differences in chemical composition between cow colostrums and milk *Bulg. J. Veter. Med.* 11(1) 3-12

[13] Morin D E, McCoy G C and Hurley W L 1997 Effects of quality, quantity, and timing of colostrums feeding and addition of a dried colostrums supplement on immunoglobulin G absorption in Holstein bull calves *J. Dairy Sci.* 80(4) 747-753

[14] Quigley J D, Martin K R, Dowlen H H, Wallis L B and Lamar K 1994 Immunoglobulin concentration, specific gravity, and nitrogen fractions of colostrum from Jersey cattle *J. Dairy Sci.* 77(1) 264-269

[15] Scammell A W 2001 Production and uses of colostrum *Austr. J. Dairy Techn.* 56(2) 74-82

[16] Fox A and Kleinsmith A 2010 Scientific and medical research related to bovine colostrums. Its relationship and use in the treatment of disease in humans *Selected publishers abstracts*, available at: http://www.immunetree.com