Formation of colostral immunity in calves on the background of the application of immunostimulators to cows

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Abstract. A scientific and practical substantiation of the need for the timely formation of colostral immunity in calves to create nonspecific protection of the body and adaptation of newborns to new environmental conditions is given, which is the most important problem of modern veterinary science and practice. Colostral immunity is immunity that develops in newborns due to colostral immunoglobulins during the first 24-36 hours of life. For some newborn farm animals (horses, ruminants and pigs), antibodies are transmitted to offspring only through colostrum in the early postnatal period. In order to increase the nonspecific defenses of the body of mothers cows, the formation of colostral immunity in newborn calves and the realization of the biological resource potential of the body, immunostimulants were used, developed by scientists of the Chuvash State Agrarian University: Prevention-N-B-S and Salus-PE.

1. Introduction

Resistance and the ability to resist or fight pathogenic factors is one of the main physiological functions of the body. Therefore, the study of the immune status is a problem of particular importance. Also, the problem of modern veterinary science and practice is the frequent morbidity of newborn calves with various diseases of non-infectious etiology. These problems cause significant damage to agriculture. In this regard, an increase in the quality and quantity of livestock products largely depends on the health and directed rearing of young animals [1].

In modern animal husbandry, there is a great interest in the development and implementation of the genetic potential of the reproductive and adaptive resources of the animal organism. This direction requires careful correction of the immunological and metabolic processes of productive animals.

To ensure the emergency adaptation of the body of newborn calves to the new hygienic conditions of the environment and the prevention of various diseases of a non-infectious nature, the latest veterinary science already uses methods of creating colostrum immunity.

The physiological and biochemical state of the body of mothers during the dry period plays an important role in the formation of colostral immunity in newborns. In some cases, pre-immunization of pregnant cows is used to achieve the best immune response of newborn calves to the pressure of environmental and technological stress factors. To increase the body's resistance, various drugs are used, many of them consist of their natural components, which contribute to the correct and free flow of redox processes. The transmission of immunoglobulins to the newborn is the most important stage in the consolidation of passive immunity in calves, due to the fact that the mother's placenta has a
syndesmochorial structure, which blocks the transfer of maternal immunoglobulins to the fetus. Therefore, at birth, the calf is agammaglobulimic (does not have its Ig). Colostrum is a major factor in the early postnatal period for the healthy growth and development of a strong immune calf [2].

The share of calves deaths in the first days of life from the total mortality reaches 56%, in the second week of life – 28% and in the first month of life – 22%. Therefore, it is important to observe the hygienic feeding and maintenance regimes of mother cows before and during pregnancy, the timing, quantity and quality of the fed colostrum to the newborn. The state of immunological vulnerability of calves changes after receiving colostrum, which is the only source of protective antibodies for the newborn [3].

Colostrum is formed in the late stages of pregnancy, and is the secret of the mammary glands, which is used to feed the newborn calf and obtain the necessary elements for extra-uterine development. In addition to immunoglobulins, colostrum also contains useful fats, minerals and vitamins, if you compare it with milk.

Immunoglobulin type IgA, the content of which in colostrum is not more than 6%, is aimed at protecting the mucous membranes, including the mucous membrane of the gastrointestinal tract, which protects against the penetration of pathogenic microorganisms and their reproduction [4].

IgM immunoglobulin, the content of which in colostrum is not more than 7%, serves as a primary defense mechanism, is aimed at protecting against septicemia and carries agglutinating antibodies. In addition, colostrum contains carbohydrates, fats, proteins, vitamins and minerals in a light form, which are easy to digest. They also contain T-lymphocytes, which survive in the intestines of calves for up to 36 hours. The ability of colostrum white blood cells to be transported into the blood of a newborn and to influence the antigen-presenting ability of calves’ white blood cells was established [5].

In the early postnatal period, the content of T-cell subpopulations in the peripheral blood of calves is comparable to the concentration of those in adult animals, while the population of B-cells increases significantly with the age of animals. The functional activity of neutrophils in calves increases from the first week of life. In addition, it was found that immunocompetent cells transmitted with colostrum increase the proliferative activity of the white blood cells of newborn calves to those antigens against which their mothers had a preliminary immune response, and participate in the immunoregulation of newborns [6].

On the first day after birth, the intestinal epithelium can absorb colostrum Ig immunoglobulins without prior lysis. Antibodies become active after entering the blood and lymphatic system of intact protein molecules, which are absorbed without food breakdown. The absorption of immunoglobulins obtained with colostrum is non-selective and is carried out due to the process of pinocytosis mainly in the terminal part of the small intestine. However, it was found that absorption occurs throughout the small intestine, and this ability increases in the direction from the duodenum to the ileum, achieving the greatest activity there. The effective absorption of Ig lasts no more than 24 hours, decreasing to 50% 6 hours after birth.

Therefore, the problem of morbidity caused by the immaturity of the immune system of calves, and the preservation of livestock in the postnatal period is very relevant. And passive immunity is just formed during the feeding of colostrum and the absorption of immunoglobulins, vitamins and minerals. Calves of the first days of life are quite vulnerable to the occurrence of diseases of various etiologies, so to preserve the livestock and strengthen the immune system, various methods of immunostimulation are used and further studies are conducted [7].

The purpose of the work is the formation of colostrum immunity in calves to create nonspecific protection of the body against the background of the use of immunostimulants to cows.

2. Materials and methods
Experimental studies were carried out in the conditions of the Agricultural Production Cooperative “Bronevik” of the Vurnarsky district of the Republic of Chuvashia. The biomaterials obtained during the experiment were analyzed in the Budget Institution of the Chuvash Republic “Chuvash Republican Veterinary Laboratory” The State Veterinary Service of Chuvashia and in the clinical and hematology
laboratory of the Chuvash State Agrarian University (Russia). The objects of the study were black-and-white cows of the deadwood period and calves of the growing period up to 180 days.

For the experiment, three groups of cows were selected after the launch on the principle of analogues, taking into account the clinical and physiological state, productivity, age and live weight of 10 animals each. When selecting the groups, the productive qualities, physiological state and live weight of the animals were taken into account. All the animals had the same diet and were kept in the same conditions.

Groups of newborn calves were selected according to the same principle. The main indicators of the microclimate in the cowshed and maternity ward are shown in table 1.

| Table 1. Indoor microclimate for cows. |
|----------------------------------------|
| Indicator                              | Room                   |
|                                        | cowshed    | maternity ward department |
| Air temperature, °C                    | 10.1±0.25   | 15.0±0.39                |
| Relative humidity, %                   | 70.3±1.14   | 67.3±0.76                |
| Air speed, m/s                         | 0.31±0.02   | 0.28±0.02                |
| Light coefficient                      | 1:14        | 1:13                     |
| Natural light ratio, %                 | 0.63±0.04   | 0.68±0.02                |
| Concentration of pollutants in the air:|                                        |
| ammonia, mg/m³                         | 13.5±0.60   | 8.7±0.52                 |
| hydrogen sulfide, mg/m³                | 7.2±0.26    | 4.8±0.29                 |
| carbon dioxide, %                      | 0.20±0.01   | 0.14±0.01                |
| bacterial contamination, thousand/m³   | 43.7±1.56   | 30.3±1.02                |
| dust content, mg/m³                    | 4.2±0.31    | 2.7±0.25                 |

According to the data presented in the table, it can be concluded that the microclimate in the cowshed and maternity ward corresponded to zoohygienic standards. So, the parameters of the air pool in the autumn-winter period in the cowshed, and after calving cows in the winter period in the maternity ward

In order to increase the non-specific protective forces of the body of mother cows, to form colostral immunity in newborn calves and to realize the bioresource potential of the body, immunostimulants developed by scientists of the Chuvash State Agrarian University were used: Prevention-N-B-S and Salus-PE.

The scheme of the experiment is shown in figure 1. The cows of the 1st experimental group were injected intramuscularly with Prevention-N-B-S at a dose of 10 ml three times for 45-40, 25-20 and 15-10 days before the expected calving date, the 2nd experimental group – Salus-PE at the specified dose and time, the cows of the control group were not injected with immunostimulants. Calves of the 1st and 2nd experimental groups were injected intramuscularly with Prevention-N-B-S and Salus-PE twice on the 2nd, 3rd and 7th, 9th days of life at a dose of 3 ml.

For intramuscular injection, a needle with a diameter of 40 mm with a sharp bevel, with a sharp and straight, not curved cannula, was used. Blunt needles will cause the animals more pain. Disposable syringes were used for the procedure. Intramuscular administration to the cow was carried out according to the scheme:

1. The area for injection was selected.
2. The needle insertion site was wiped with an alcohol solution.
3. The syringe was brought to the body of the animal at a right angle.
4. A needle with a depth of 2/3 was inserted.
5. The plunger pushed the drug out of the syringe.
6. The needle was removed from the body.
7. The injection site was treated with iodine.
The procedure is fast. The cow does not have time to react to the pain.

Prevention-N-B-S and Salus-PE preparations are biostimulants containing a polysaccharide mixture of Saccharomyces cerevisiae immobilized in agar gel, with the inclusion of a benzimidazole derivative and a bactericidal preparation. The inventions are intended to increase the nonspecific resistance of the body, prevention and treatment of gynecological diseases in cows, as well as for the prevention of diseases of non-infectious etiology of the respiratory and digestive organs, activation of hematopoiesis, growth and development of calves. The developer organization is the Federal State Budgetary Educational Institution of Higher Professional Education ‘Chuvash State Agricultural Academy’ (Cheboksary, Russia).

![Figure 1. Experience diagram.](image)

3. Results and discussion
It was found that the body temperature in the cows of the experimental and control groups during the study was within the physiological norm.

| Animal Group | Observation period, day | Body temperature, °C | Heart rate, beats / min | Breathing, mov/min |
|--------------|-------------------------|----------------------|------------------------|-------------------|
| Control      | before calving: 35 – 30 | 38.2±0.14            | 76±1.16                | 21±0.81           |
|              | after calving: 15 – 10  | 38.0±0.10            | 77±0.87                | 22±0.55           |
|              | 10 – 5                  | 38.1±0.06            | 77±1.03                | 22±0.40           |
|              | 3 – 5                   | 38.1±0.09            | 76±1.03                | 22±0.32           |

1 experienced

| Control      | before calving: 35 – 30 | 38.2±0.13            | 75±1.56                | 22±0.68           |
|              | after calving: 15 – 10  | 38.0±0.10            | 76±1.24                | 22±0.51           |
|              | 10 – 5                  | 38.2±0.09            | 76±0.93                | 22±0.51           |
|              | 3 – 5                   | 38.2±0.11            | 76±1.02                | 22±0.58           |

2 experienced

| Control      | before calving: 35 – 30 | 38.3±0.13            | 76±0.93                | 21±1.16           |
|              | after calving: 15 – 10  | 38.2±0.12            | 77±0.71                | 22±0.93           |
|              | 10 – 5                  | 38.2±0.09            | 77±0.86                | 21±0.51           |
|              | 3 – 5                   | 38.1±0.12            | 76±0.73                | 22±0.24           |
The results of studies of the physiological state of animals of experimental groups, presented in table 2, indicate that after intramuscular administration of Prevention-N-B-S to cows of the 1st experimental group – B in a dose of 10 ml for 45-40 days, 25-20 and 15-10 days before calving, the 2nd experimental group – Salus-PE based on the same calculation and at the specified time, the parameters of the physiological state of animals during the observation period were within the limits of physiological norms and the difference in the corresponding values compared to the control was insignificant (P>0.05).

The pulse rate in cows of the 1st and 2nd experimental and control groups increased from 77 to 78 vibrations/min, from 76 to 77 and from 75 to 76 vibrations/min 35-30 – 10-5 days before calving. After calving in 4-6 days, a decrease in the pulse rate was found in animals of the 2nd and control groups, and in cows of the 1st experimental group, it remained at the same level. The frequency of respiratory movements in animals of all groups varied in the range of 22-23 mov/min [8].

Consequently, the immunostimulants used in the experiments did not affect the physiological state of the cows body.

| Table 3. Morbidity and reproductive qualities of cows. |
|-------------------------------------------------------|
| **Indicator**                                           | **Animal Group** |
|                                                       | control | 1 experienced | 2 experienced |
| Number of animals                                      | 10      | 10            | 10            |
| Terms of placenta separation, h                        | 13.2±1.02 | 7.2±0.58*    | 6.8±0.66*    |
| Detention of the placenta                              | 4       | -             | -             |
| Subinvolution of the uterus                            | 3       | 1             | -             |
| Endometritis                                           | 2       | 1             | -             |
| Mastitis                                               | 2       | -             | -             |
| Terms of occurrence of 1 hunt, day                     | 43.2±1.36 | 31.6±0.93*   | 29.0±0.71*   |
| Insemination index                                     | 2.6±0.43 | 1.6±0.24*     | 1.4±0.19**    |
| Service period, day                                    | 87.0±3.05 | 64.6±1.94**  | 58.6±1.50**  |
| Fertilized cows:                                       |         |               |               |
| on the first hunt                                      | 2       | 5             | 6             |
| On the second hunt                                     | 3       | 4             | 4             |
| The third hunt                                         | 5       | 1             | -             |
| **P<0.05; ** P<0.01.**                                  |         |               |               |

When studying the gynecological condition of cows, it was found that under the influence of the immunostimulants Prevention-N-B-S and Salus-PE, the time of separation of the fetal membranes was reduced, the retention of the afterbirth was excluded, postpartum complications and breast diseases were prevented (table 3).

An increase in the number of red blood cells and the concentration of hemoglobin in the blood of animals of the experimental groups against the background of intramuscular administration of immunostimulants indicates an improvement in their hematopoiesis, and an increase in the number of white blood cells indicates the activation of cellular protective factors of the body (table 4) [9].

A decrease in the number of eosinophils in the blood of cows 10-5 days before calving and 3-5 days after calving indicates that they experienced stress, and an increase in these granulocytes in the blood of animals under the influence of immunostimulants is caused by the activation of nonspecific resistance of the body (table 5). Given that neutrophils have pronounced phagocytosis, the established qualitative changes in the stages of development of these granulocytes and the shift of the neutrophil nucleus to the right indicate the activation of nonspecific resistance of the body. Immunostimulants stimulated the production of lymphocytes by hematopoietic organs, i.e. cellular factors of nonspecific resistance.

The phagocytic activity of white blood cells, plasma lysozyme activity, bactericidal activity of blood serum and the content of immunoglobulins in new-bodied cows of the 1st and 2nd experimental groups were higher than in the control (P<0.05-0.001), which indicates the stimulation of nonspecific
Table 4. Hematological parameters of cows.

| Group animals | Deadlines observations, day | Red blood cells, x10¹²/l | Hemoglobin, g/l | White blood cells, x10⁹/l |
|---------------|-----------------------------|--------------------------|----------------|--------------------------|
|               | before calving              | after calving            |                |                          |
| Control       | 35 – 30                     | 5.74±0.17                | 105.2±1.39    | 7.18±0.14                |
|               | 15 – 10                     | 5.98±0.17                | 104.4±1.08    | 7.14±0.19                |
|               | 10 – 5                      | 5.98±0.15                | 103.8±1.24    | 7.30±0.25                |
|               | 3 – 5                       | 6.08±0.22                | 104.0±1.00    | 7.36±0.28                |
| 1 experienced | 35 – 30                     | 5.76±0.14                | 106.0±0.84    | 7.12±0.23                |
|               | 15 – 10                     | 6.08±0.07                | 107.2±0.73    | 7.36±0.25                |
|               | 10 – 5                      | 6.28±0.18                | 107.6±1.36    | 7.76±0.16                |
|               | 3 – 5                       | 6.64±0.13                | 108.4±1.25*   | 7.62±0.23                |
| 2 experienced | 35 – 30                     | 5.80±0.17                | 105.0±0.71    | 7.14±0.35                |
|               | 15 – 10                     | 6.18±0.11                | 106.6±0.93    | 7.48±0.30                |
|               | 10 – 5                      | 6.24±0.14                | 108.2±1.36*   | 7.80±0.25                |
|               | 3 – 5                       | 6.70±0.09*               | 110.4±1.12**  | 7.78±0.16                |

* P<0.05; ** P<0.01

Table 5. Leukocyte formula of cow blood.

| Group animals | Deadlines observations, day | Group and type of white blood cells | neutrophils | eosinophils | basophils | lymphocytes | monocytes |
|---------------|-----------------------------|-------------------------------------|-------------|-------------|-----------|-------------|-----------|
|               | before calving              |                                     | stick-nuclear services | segmented-core services | |
| Control       | 35 – 30                     | 1.2±0.20                            | 5.0±0.32     | 4.0±0.45    | 27.0±1.14 | 57.8±1.24   | 5.0±0.37  |
|               | 15 – 10                     | 1.4±0.24                            | 5.8±0.20     | 4.8±0.37    | 26.8±0.37 | 56.6±1.17   | 4.6±0.58  |
|               | 10 – 5                      | 1.2±0.37                            | 4.8±0.37     | 3.8±0.37    | 27.4±0.93 | 58.2±1.11   | 4.6±0.40  |
|               | 3 – 5                       | 1.0±0.32                            | 4.8±0.80     | 4.2±0.20    | 27.0±0.60 | 59.0±0.60   | 4.0±0.51  |
| 1 experienced | 35 – 30                     | 1.2±0.20                            | 5.2±0.37     | 2.8±0.37    | 27.6±0.51 | 58.0±0.55   | 5.2±0.40  |
|               | 15 – 10                     | 1.0±0.32                            | 6.2±0.20     | 2.6±0.24    | 27.4±0.24 | 58.0±0.32   | 4.8±0.40  |
|               | 10 – 5                      | 0.8±0.20                            | 5.6±0.81     | 2.4±0.24    | 27.8±0.92 | 58.8±1.20   | 4.6±0.32  |
|               | 3 – 5                       | 0.6±0.24                            | 5.4±0.51     | 2.4±0.24*   | 27.2±0.92 | 59.6±0.81*  | 4.8±0.51  |
| 2 experienced | 35 – 30                     | 1.0±0.32                            | 5.2±0.37     | 2.4±0.24    | 28.0±0.45 | 58.4±0.51   | 5.0±0.32  |
|               | 15 – 10                     | 0.6±0.24                            | 6.4±0.24     | 2.4±0.24    | 27.2±0.37 | 58.6±0.40   | 4.8±0.37  |
|               | 10 – 5                      | 0.4±0.24                            | 5.4±0.51     | 2.2±0.20    | 27.6±1.33 | 59.4±0.93   | 5.0±0.84  |
|               | 3 – 5                       | 0.4±0.24                            | 5.6±0.51     | 2.2±0.24*   | 27.6±0.97 | 59.8±1.00*  | 4.4±0.80  |

* P<0.05; ** P<0.01.

In the calves of the experimental groups, diseases of the respiratory and digestive organs decreased by 2.5 and 6.5 times, the recovery time by 3.3 and 5.7 days and the Mellenberg coefficient – 12.7 and 15.3 times, respectively, compared with the control (P<0.05), which indicates a pronounced preventive effectiveness of the tested drugs in these diseases.

The tested immunostimulants activated both the humoral and cellular components of the nonspecific resistance of the calves body according to such indicators as plasma lysozyme activity and serum bactericidal activity, white blood cell phagocytic activity and phagocytic index [10].
4. Conclusion
Thus, the immunostimulants Prevention-N-B-S and Salus-PE, activating the nonspecific resistance of the body of maternal cows to the effects of environmental and technological factors of the environment, prevent postpartum complications and gynecological diseases of cows and improve their reproductive qualities, and in newborn calves contribute to the formation of colostral immunity, prevention of respiratory and digestive diseases. Under the influence of immunostimulants of Prophylaxis-N-B-S and Salus-PE, the time of separation of fetal membranes decreased by 6.0 and 6.4 days, the time from calving to first insemination decreased by 11.6 and 14.2 days, the insemination index by 2.0 and 2.2, the service period by 22.4 and 28.4 days.

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