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The formation of colostral immunity and its duration in calves during the first months of life

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Abstract

The paper presents the results of a study on the formation of colostral immunity and the determination of its duration during the first months of life of calves according to the indications of the level of total IgG and antigen-specific antibodies to pathogens of parainfluenza 3, respiratory syncytial infection and viral diarrhea of cattle. It has been established that blood serum of newborn calves does not contain antigen-specific immunoglobulins of class G to pathogens of viral diarrhea, respiratory syncytial infection and parainfluenza-3, and the level of total IgG is 2.2 ± 0.61 g/dm^3. The concentration of total IgG is increased to 50.50 ± 6.33 g/dm^3, and decreases to 27.25 ± 5.82 g/dm^3 for 28 days, which contributes to the formation of the immunosuppressive state at the 7th day of a calf life. Starting from 35th day, there is an increase in the concentration of total IgG due to seroconverting of its own antibodies by the body of calves. Immunization of cows-mothers against viral diarrhea, respiratory syncytial infection and parainfluenza-3 contributes to the formation of antigen-specific colostral immunity in calves in the first days of life, which is preserved in diagnostic titers during 63 days after birth.

Key words: calves, antibodies, immunoglobulins, blood serum, colostral immunity, viral diarrhea, respiratory syncytial infection, parainfluenza 3.

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1. Introduction

The first hours of life in newborn calves are one of the critical periods of early postnatal ontogenesis, since their immune system is now adapting to surrounding antigens (Atkinson et al., 2017). Due to the biological characteristics of the cow placenta, newborn calves do not have specific immunoglobulins that would provide immunological protection. For this reason, the transfer of immunoglobulins from mother to newborn during the first hours of life that occurs only with colostrum in the first hours after birth is vital for calves (Rüdiger et al., 2011; Conneely et al., 2013).

After the use of colostrum, colostar immunoglobulins appear in the peripheral blood of newborns after 2 hours. This is due to the selective absorption of antibodies through the intestine, which provides a high level of immunoglobulins in the blood of newborns.

The main immunoglobulin of colostrum, which occupies 80% of the total number of colostral antibodies, is IgG. The colostrum only comes from the blood of cows, resulting in a difference between its concentration in serum and colostrum of about 36% (Villarroel et al., 2013). That is why the level of colostral immunity in the blood of calves, which is represented by maternal antibodies, depends on the concentration of IgG in the blood, and, accordingly, their colostrum.

The main biological significance of IgG is the opsonization of antigens, resulting in the latter being absorbed and laced by phagocytic cells (Conneely et al., 2013). This mechanism is also activated during immun-ization of animals against widely spread pathogens of viral diseases such as viral diarrhea, respiratory syncytial infec-tion, parainfluenza-3, etc. (Rüdiger et al., 2011; Gonzalez al., 2014; Windeyera et al., 2014). Against the backdrop of high levels of specific colostral antibodies in the calf, neutralization of vaccine antigens occurs, resulting in a significant reduction in the immunizing effect of the vaccine used (Atkinson et al., 2017; Masyuk et al., 2018). Therefore, especially important Tin the process of formation of an effective scheme of specific immune prevention is to determine the time of immunization of animals.

The purpose of the work was to study the formation of colostral immunity and determine its duration in calves during the first months of life.

2. Materials and methods

The research was carried out on the basis of SRC biosafety and environmental control of the resources of the agroindustrial complex DSAEU. Blood serum was collected from calves to colostrum and after 7, 28, 35, 63 and 91 days of life for the study. Blood was collected from 5 animals from each age group. Mothers of the studied calves were immunized against BVDV, BRSV and BPI-3 polyvalent vaccine 5 and 2 weeks before fertilization.

The determination of the concentration of total immunoglobulin (Ig) G and specific antibodies to pathogens of parainfluenza-3 (BPI-3), respiratory syncytial infection (BRSV) and viral diarrhea of cattle (BVDV) was performed by ELISA using appropriate commercial test systems Bio- X Bovine Immunoglobulin (Belgium), Bio-X Bovine ParaInfluenza 3 Virus (Belgium), INGENASA Bovine Respiratory Syncytial Virus Compac (Spain), ID Screen BVD Antibody Competition (France). Reading of the optical density of the samples under study was performed on a BioTek ELx800 (USA) Absorbance Microplate Reader.

3. Results and discussion

According to the results of the conducted studies, the level of total IgG and antigen-specific antibodies of colostral origin in the blood serum of calves during the early postnatal period of ontogenesis was determined.

Investigation of the level of non-specific IgG in blood serum of calves during the first 91 days of life allows monitoring the effectiveness of colostral immunity formation and evaluating its duration, which is essential in the analysis of the results of the study of colostral immunity by specific immunoglobulins.

The obtained results indicate that in blood serum of calves, the colostrum contains antibodies of class G (fig. 1) indicating the functional activity of the immune system in the calves even in the fetal period.

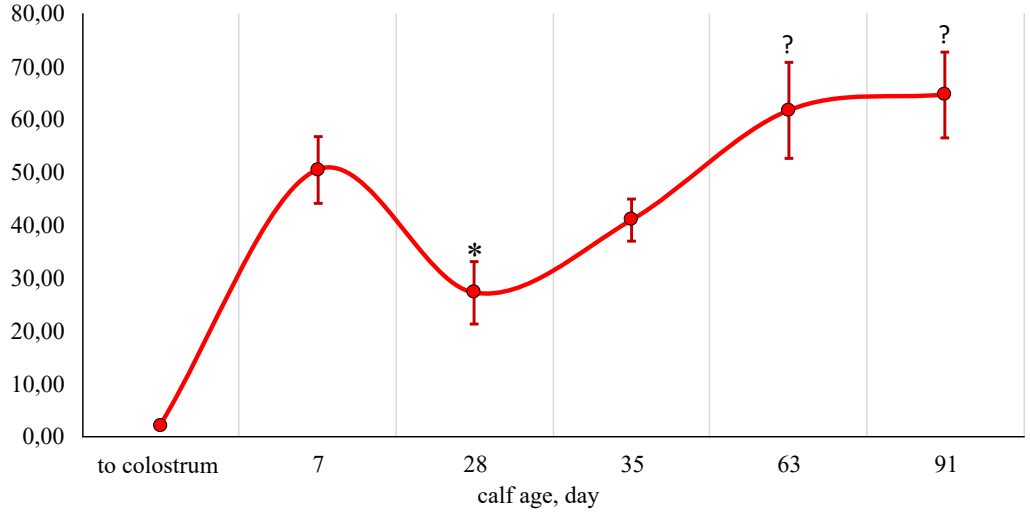

Fig. 1. Level of total IgG in blood serum of calves (M ± m, g/dm^3, n = 5)

Note: 1. * – r ≤ 0.05 in relation to calves' figures of 7th day of life; 2. Δ – P ≤ 0.05 with respect to calves of 28th day of life.

It should be noted that at this time, the level of IgG is the smallest and is 2.2 g/dm^3, which is conditioned by the biological peculiarities of the relationship between the mother organism and the fetus of the cattle and contributes to the formation of the physiological immune deficiency of newborns (Masyuk et al., 2012)

Studies of blood serum from calves at 7th day of life revealed a sharp increase (almost by 23 times) of IgG levels up to 50.50 g/dm^3, in relation to newborn calves to colonization, indicating the absorption of colostral immunoglobulins in the intestines and saturation of animal blood.

At the 28th day of life, a probable decrease in the IgG concentration in the blood serum of calves to 27.25 g/dm^3 (P ≤ 0.05) was observed compared to calves in the 7th day of life, due to the natural catabolism of maternal antibodies in the continuation of postnatal ontogenesis (Waldner & Rosengren, 2009).

Starting from 35th day of life and further in the blood of calves, a gradual increase in the level of total IgG was found. Thus, at 35th day, the level of IgG increased by 1.51 times, at 63th day – by 2.27 times (P ≤ 0.05), and at 91st day – by 2.38 times (P ≤ 0.05) compared with Indicators of calves at 28th day of life, due to the activation of its own immune system of calves (Reschke et al., 2017).

Consequently, until sucking colostrum in blood, calves contain a low level of total IgG, which sharply increases during the first 7 days of life against the background of colostrum casting, and decreases to 27.25 g/dm^3 at day 28 from birth, which causes the formation of age-related immunodeficiency of the neonatal period. From the 35th to the 91st day of life, a gradual increase in the level of IgG was observed compared to the calves of the 28th day of life, with the activation of mechanisms of its own immune system.

Investigation of colostral antigenspecies to viral diarrhea, parainfluenza-3, respiratory syncytial IgG infections in serum of calves whose mothers were immunized against the above-mentioned pathogens, it was established that all animals are seronegative before the colostrum is produced (Table 1), which is due to the invasion of the placenta of cattle for immune proteins (Bachmann et al., 1982; Abd et al., 2012; Meganck et al., 2014).

Table 1
The level of antigen-specific IgG to the pathogens BPI-3, BRSV, BVDV in serum calves (M ± m, n = 5)

		BPI-3	BRSV	BVDV	BPI-3	BRSV	BVDV
		S/P, %	OD, Un.	S/N, %	of all investigated / seropositive samples		
Cut off		20	0,768^{X}	40^{X}			
diagnostic titer		1:100	1:4	1:20			
before make colostrum		14.43 ± 1.81	1.06 ± 0.09	66.89 ± 7,26	5/0	5/0	5/0
age of calves, days	7	101.17 ± 4.91	0.08 ± 0.01	12.25 ± 0.89	5/5	5/5	5/5
	28	84.68 ± 4.04*	0.11 ± 0.01*	16.42 ± 2.71	5/5	5/5	5/5
	35	68.19 ± 9.09*	0.17 ± 0.03*	22.09 ± 1.11*	5/5	5/5	5/5
	63	48.62 ± 5.43**	0.43 ± 0.09**	27.67 ± 1.61**	5/4	5/5	5/5
	91	39.19 ± 6.79***	0.53 ± 0.06***	71.60 ± 10.76***	5/3	5/5	5/4

Note: 1. * – r ≤ 0.05; ** – P ≤ 0.01; *** – P ≤ 0.001 in relation to the calves of the 7th day of life; 2. The X-values have an inverse-proportional dependence.

At 7th day of life all calves showed antigens-specific antibodies of class G to the parainfluenza-3 virus, the level of which is highest during the whole investigated period. In the future, a gradual decrease in the concentration of specific antibodies is observed, as indicated by a decrease in the S/P index at the 28th day of life by 16.3% (P ≤ 0.05), at 35th day – by 32.6% (P ≤ 0.05), at 36th day – 51.9% (P ≤ 0.01), and at the 9st day the average value of S/P was the smallest and was probably lower by 61.3% (P ≤ 0.001) compared to the calves of the 7th day of life.

It should be noted that against the background of the downward dynamics of the antibody level, all animals of the 28th and 35th day of age are seropositive, indicating a fully formed group immunity, whereas at 63rd and at 91st day, 1 out of 5 and 2 out of 5 samples are seronegative for parainfluenza-3 in diagnostic titre 1:100. The presence of non-immune calves or low-antibody animals promotes the activation of the aforementioned infection in the herd, resulting in an increase in the pressure of the parainfluenza-3 virus.

Similar results were obtained in the study of specific antibodies to antigens causative agent respiratory syncytial infection. All investigated groups of calves, starting from 7th day of age, have a 100% formed group immunity to respiratory syncytial infection, which is represented by specific antibodies of colostral origin, as evidenced by their gradual, but significant decrease over 91 days of life, compared to calves of the 7th day of life. At 7th day of life, the highest level of antigen-specific BRSV antibodies of class G was detected, which is evidenced by the smallest value of the optical density of the investigated samples.

The results of the study of colostral antibodies specific to the antigens of the pathogen of viral diarrhea in cattle indicate a fully-formed group immunity in calves of 7th, 28th, 35th and 63rd day. Thus, in the blood of calves of 7th day of age, the highest concentration of antigens specific to colostral antibodies was revealed, as indicated by the low value of the S/N index, which is inversely proportional to the level of immunoglobulins. In calves of 28th, 35th, 63rd and 91st day age, the S/N level is gradually increased by 1.34, 1.81 (P ≤ 0.05), 2.26 (P ≤ 0.01) and 5.84 (P ≤ 0,001) times, indicating a decrease in the anti-antibody specificity of the pathogen of antibodies. It should be noted that at the 91st day of life, 1 out of 5 calves is seronegative to the pathogen of BVD, which forms a "serological window", which can contribute to the infection of seronegative calves by the pathogen of viral diarrhea of cattle.

Consequently, colostrum immunity to pathogens of viral diarrhea, respiratory syncytial infection and parainfluenza-3 in calves derived from immunized mothers is fully formed and maintained at a high level during the first 35 days of life, after which the concentration of specific antibodies is gradually reduced, which is associated with the physiological catabolism of colostral antibodies, and starting from 63rd day animals have been identified that are seronegative and, accordingly, are susceptible to the aforementioned pathogens of viral diseases of calves.

4. Conclusions

Colostrum excretion does not contain antigen-specific immunoglobulins of class G to pathogens of viral diarrhea, respiratory syncytial infection and parainfluenza-3, and the level of total IgG is 2.2 ± 0.61 g/dm^3 in blood serum of newborn calves.

The concentration of total IgG is increased to 50.50 ± 6.33 g/dm^3, and decreases to 27.25 ± 5.82 g/dm^3 for 28 days, which contributes to the formation of the immunosuppressive state at 7th day of life in calves. Starting from 35th day, there is an increase in the concentration of total IgG due to seroconverting of its own antibodies by the body of calves.

Immunization of cows-mothers against viral diarrhea, respiratory syncytial infection and parainfluenza-3 contributes to the formation of antigen-specific colostral immunity in calves in the first days of life, which is preserved in diagnostic titers during 63 days of birth.

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