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Colostral immunity as an analytical factor in predicting the development of acute respiratory viral infections in calves

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SUMMARY
To reduce the incidence of acute respiratory viral infections in cattle, routine vaccination of mother cows is carried out. There is a direct dependence of the passive immunity level in calves on the vaccination efficacy in cows. The paper presents the results of a study of colostral immunity in calves and post-vaccination immunity in cows against the agents of acute respiratory viral infections in agricultural facilities located on the territory of the Ural and Volga Federal Districts. In the farms under study ($n = 10$), cattle are vaccinated with inactivated vaccines: "COMBOVAC" and "COMBOVAC-R" (OOO Vetbiokhim, Russia), "HIPRABOVIS® 4" (Laboratorios Hipra, S. A., Spain). The study of postvaccinal immunity level in cows showed that the levels of antibodies to infectious bovine rhinotracheitis virus (5.3–8.0 $\log_2$), bovine viral diarrhea virus (3.5–4.8 $\log_2$), bovine parainfluenza-3 virus (6.8–8.5 $\log_2$) and bovine respiratory syncytial virus (4.2-4.5 $\log_2$) in cattle confer protection. When evaluating the results of serological diagnostics of passive immunity in calves to acute respiratory viral infections, it was found that the level of colostral antibodies in them is lower than the level of post-vaccination antibodies in cows: to infectious bovine rhinotracheitis virus by 34.2–58.8%; to bovine diarrhea virus by 37.5–45.0%; to bovine parainfluenza-3 virus by 14.7–35.4 and to bovine respiratory syncytial virus by 23.5-42.2%. To ensure epizootic favourable situation, it is proposed to adjust the schedules of vaccination against bovine diseases in herds, infected by acute respiratory viral infections for dairy farms under study.

Keywords: Cattle, respiratory viral infections, vaccination, colostral immunity, post-vaccination immunity.

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Колостральный иммунитет как аналитический фактор прогнозирования развития острых респираторных вирусных инфекций у телят

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РЕЗЮМЕ

Для снижения заболеваемости крупного рогатого скота острыми респираторными вирусными инфекциями проводится плановая вакцинация коров-матерей. Существует прямая зависимость уровня пассивного иммунитета у телят от эффективности вакцинопрофилактики коров. В работе представлены результаты исследования напряженности колострального иммунитета у телят и поствакцинального иммунитета у коров против возбудителей острых респираторных вирусных инфекций в сельскохозяйственных организациях, находящихся на территории Уральского и Приволжского федеральных округов. В обследованных хозяйствах ($n = 10$) крупный рогатый скот прививают инактивированными вакцинами: «КОМБОВАК» и «КОМБОВАК-Р» (ООО «Ветбиохим», Россия), «HIPRABOVIS® 4» (Laboratorios Hipra, S. A., Испания). Исследование напряженности поствакцинального иммунитета у коров показало, что уровень антител к возбудителям инфекционного ринотрахеита (5,3–8,0 $\log_2$), вирусной диареи (3,5–4,8 $\log_2$), парагриппа-3 (6,8–8,5 $\log_2$), респираторно-синцитиальной инфекции (4,2–4,5 $\log_2$) крупного рогатого скота соответствует протективному. При оценке результатов серодиагностики пассивного иммунитета у телят к острым респираторным вирусным инфекциям установлено, что уровень колостральных антител у них ниже, чем уровень поствакцинальных антител у коров: к вирусу инфекционного ринотрахеита на 34,2–58,8%; к вирусу диареи на 37,5–45,0%; к вирусу парагриппа-3 на 14,7–35,4%; к респираторно-синцитиальному вирусу на 23,5–42,2%. Для обеспечения эпизоотического благополучия предложено провести коррекцию программ специфической профилактики заболеваний крупного рогатого скота в неблагополучных по острым респираторным вирусным инфекциям стадах для подвергнутых обследованию молочно-товарных ферм.

Ключевые слова: Крупный рогатый скот, острые респираторные вирусные инфекции, вакцинация, колостральный иммунитет, поствакцинальный иммунитет.

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INTRODUCTION

Vaccination plays a key role in protecting of cattle from acute respiratory viral infections (ARVIs) and bovine health improving [1]. The main result of systematic and active vaccination is the development of herd specific immunity, which reduces the incidence and, as a rule, reduces the circulation of ARVI agents in the herd [2, 3].

The basis of herd specific immunity is the percentage of individuals that are immune to a particular infection [4]. This takes into account individuals with both active immunity, achieved by vaccination, and with passive immunity, which is formed as a result of the introduction of specific antibodies and/or transfer of immunocompetent cells. The level of specific immunity and duration of protective immunity (the immunological memory phenomenon) depend on the proportion of immune individuals in the population) [4, 5]. The structure of the proportion of immune individuals in different age groups of cattle varies significantly. For example, in one-month-old calves, passive immunity prevails, and the active immunity is predominant in dairy cows. Numerous studies have shown a direct dependence of passive immunity level in calves on the effectiveness of ARVI vaccination in maternal cows [6–9].

Colostral immunity in calves is the main factor that inhibits ARVI virus penetration into cells and their replication before active vaccination programs are started to be implemented. As a rule, a low level of antibodies or their decrease causes the rise in the incidence of respiratory viral infections in young animals. It is important to choose the right time for vaccination, so that, on the one hand, no neutralization of vaccine antigens by colostral immunoglobulins could occur in calves, and on the other – to form a long-term strong immunity in a timely manner. In each herd, this period will depend on many factors, including the level of colostral antibodies in calves (which is associated with the post-vaccination immunity of mother cows, as well as the colostrum feeding technology) and their half-life.

The aim of the study was to analyze the presence of passive antibodies in young cattle compared to the post-vaccination immunity of mother cows in order to predict the onset of ARVI manifestation and plan the vaccination schedule.

MATERIALS AND METHODS

The research was carried out in the Department of Monitoring and Prediction of Infectious Diseases of the Federal State Budgetary Institution, the Ural Federal Agrarian Research Centre, the Ural Branch of the Russian Academy of Sciences (Yekaterinburg) within the framework of Category 160 of the Program of Fundamental Scientific Research by State Academies of Sciences – "Molecular-biological and nanobiotechnological methods of developing new-generation biological products, technologies and methods of their application to combat highly dangerous infectious, parasitic and non-infectious animal diseases (2013–2020)".

The object of the study was cattle kept in factory farms; biological material used was serum of cows and 3–7 day old calves ($n = 327$). Clinical samples of sera were obtained from 10 agricultural facilities located on the territory of the Ural and Volga Federal Districts. In the surveyed farms, cattle are vaccinated with inactivated vaccines: "COMBOVAC" and "COMBOVAC-R" (OOO Vetbiokhim, Russia), "HIPRABOVIS® 4" (Laboratorios Hipra, S. A., Spain).

Serological studies of sera to detect antibodies to the causative agents of infectious bovine rhinotracheitis (IBR), bovine viral diarrhea (BVD), parainfluenza-3 (BPI-3), bovine respiratory syncytial infection (BRS) were performed by indirect hemagglutination (IHA) and hemagglutination inhibition (HI) tests using domestic commercial RBC test kits. The titer of the detected antibodies was expressed as $\log_2$.

RESULTS AND DISCUSSION

The results of serological studies of sera collected from calves during their first month of life and cows are shown in Figures 1–4.

The analysis of the data obtained by the study of post-vaccination immunity in cows showed that the level of antibodies to IBR, BVD, BPI-3 and BRS viruses corresponds to the protective level. The maximum titer of postvaccinal antibodies to IBR virus (8.0 $\log_2$) was found in animals of dairy farms in the Chelyabinsk Oblast, the minimum (5.3 $\log_2$) in cows of dairy farms in the Perm Krai. The level of postvaccinal antibodies to BVD virus in the examined cows ranged from 3.5 $\log_2$ (Kurgan Oblast) to 4.8 $\log_2$ (Udmurt Republic); to BRSV – from 4.2 $\log_2$ (Chelyabinsk Oblast) to 4.5 $\log_2$ (Perm Krai); to the BPIV-3 – from 6.8 $\log_2$ (Udmurt Republic) to 8.5 $\log_2$ (Kurgan Oblast).

When analyzing the results of serological diagnostics of passive immunity to ARVIs in calves, it was found that in some cases the level of colostral antibodies was lower than the level of post-vaccination antibodies in cows.

For example, in calves of dairy farms of the Kurgan Oblast, the level of colostral antibodies to BVDV was lower by 7.14%, to the BPIV-3 by 14.70%, to the BRSV – by 23.52%. In calves of dairy farms in the Chelyabinsk Oblast, a decrease in colostral antibodies to IBR virus was registered by 58.75%, to BVD virus – by 42.50%, to BPIV-3 – by 35.36% and to BRS virus – by 38.09%. A similar pattern of colostral antibody deficiency was observed in calves of dairy farms in the Perm Krai: IBRV – by 39.62%, BVD virus – by 45.00%, BPIV-3 – by 25.35%, and to BRS virus – by 42.22%. In calves of dairy farms of the Udmurt Republic, a decrease in the

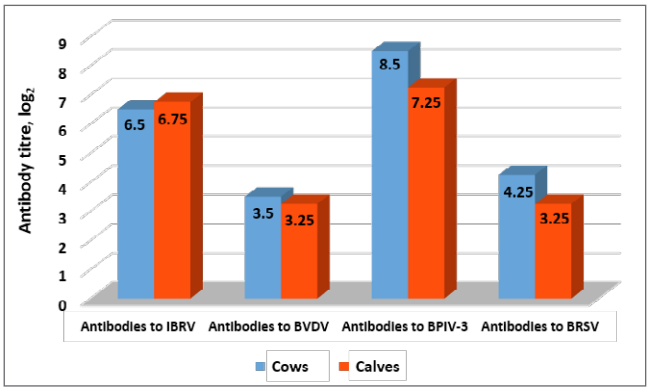

Fig. 1. The level of postvaccinal and colostral antibodies to ARVI agents in animals of dairy farms in the Kurgan Oblast

Рис. 1. Уровень поствакцинальных и колостральных антител к возбудителям ОРВИ у животных молочно-товарных ферм Курганской области

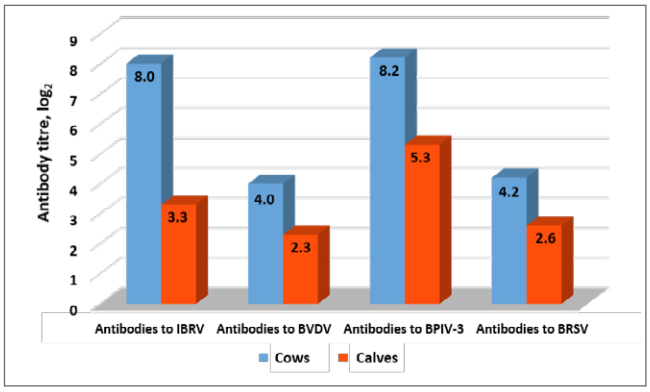

Fig. 2. The level of postvaccinal and colostral antibodies to ARVI agents in animals of dairy farms in the Chelyabinsk Oblast

Рис. 2. Уровень поствакцинальных и колостральных антител к возбудителям ОРВИ у животных молочно-товарных ферм Челябинской области

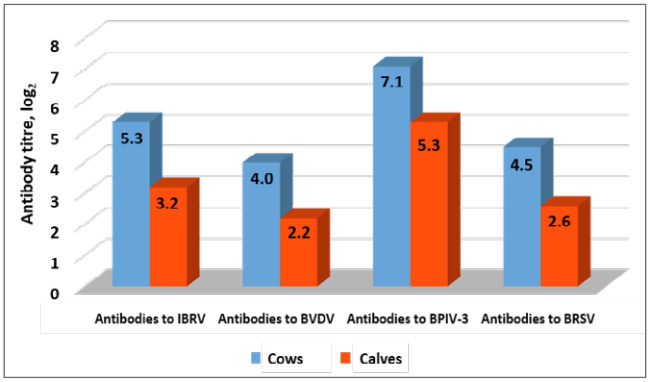

Fig. 3. The level of postvaccinal and colostral antibodies to ARVI agents in animals of dairy farms in the Perm Krai

Рис. 3. Уровень поствакцинальных и колостральных антител к возбудителям ОРВИ у животных молочно-товарных ферм Пермского края

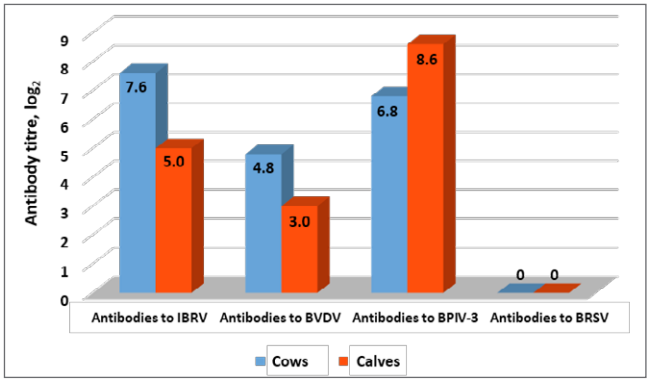

Fig. 4. The level of postvaccinal and colostral antibodies to ARVI agents in animals of dairy farms in the Udmurt Republic

Рис. 4. Уровень поствакцинальных и колостральных антител к возбудителям ОРВИ у животных молочно-товарных ферм Удмуртской Республики

level of colostral antibodies against IBRV by 34.21% and BVDV by 37.50% was established.

The main reasons for the revealed differences in the levels of colostral immunity to ARVI agents in calves and post-vaccination immunity in cows, in our opinion, may be violations of the colostrum drinking technology and/or the vaccination program in mother cows.

CONCLUSION

The results of the study showed that calves on farms in the Kurgan Oblast and Udmurt Republic had a considerably high titer of colostral antibodies compared to the level of post-vaccination antibodies to ARVI pathogens in mother cows. Therefore, the timing of the first vaccination of young animals in these herds can be shifted (taking into account the management practice) to 30–45 days of age. In the herds of the Perm Krai and the Chelyabinsk Oblast, the opposite situation is observed – there is a low transmission of immunoglobulins with colostrum to newborns: by the age of one month, the level of antibodies in the tested calves was at the minimum protective level or even lower. Vaccination of young animals in such herds should be started 1–2 weeks earlier, because a drop in the level of colostral antibodies can lead to an early incidence of ARVIs.

Thus, the determination of colostral antibody level can be used to predict the age when young cattle starts to be affected with respiratory virus infections, and to improve the technology of colostrum feeding, as well as to adjust vaccination schedules to prevent acute respiratory viral infections in cattle herds.

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