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Neutralising antibody response in cattle after vaccination with monovalent modified-live vaccine against bluetongue virus serotype 2

G. Savini[(1)], F. Monaco[(1)], P. Calistri[(1)], G. Panichi[(2)], A. Ruiu[(3)], A. Leone[(1)] & V. Caporale[(1)]

(1) Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise 'G. Caporale', Via Campo Boario, 64100 Teramo, Italy
(2) Local Health Unit No. 5 of Oristano, Veterinary Department, Via Giosuè Carducci, 09170 Oristano, Italy
(3) Sezione di Oristano, Istituto Zooprofilattico di Sperimentale della Sardegna 'G. Pegreffi' Via Atene, Zona Industriale, 09170 Oristano, Italy

Summary

The antibody response following bluetongue (BT) vaccination under both field and experimental conditions, and the duration of colostral antibodies in calves born from vaccinated dams, were evaluated. To this end, 1 005 animals of various breeds and ages were selected at random from 10 herds in the Sardinian province of Oristano. During the first year of the vaccination campaign, the animals selected were vaccinated against BT virus (BTV) serotype 2 between July and August 2002. Blood samples were taken from all animals monthly for three months after vaccination and tested for the presence of BT antibodies using the competitive enzyme-linked immunosorbent assay (c-ELISA) and the virus neutralisation (VN) test. Serological results from field vaccinated animals were compared with those obtained following the vaccination of five animals under experimental conditions. Out of 1 005 animals, 994 (98.1%) developed BT antibody following vaccination whereas antibody was detected in all cows vaccinated under experimental conditions. Both groups showed the highest median titres of 1:160 after two months. To assess the duration of colostral antibodies in calves born from vaccinated dams, the sera of 47 calves were screened using the c-ELISA and VN test. Calves were divided into three age groups: Group A included 22 calves aged 1 to 25 days, Group B 13 calves aged 26 to 39 days and Group C 12 calves aged 40 to 60 days. Antibody was detected in calves in Groups A and B (68.2% and 46.1%, respectively) whereas the calves in Group C were serologically negative.

Keywords

Bluetongue – Cattle – Colostral antibody – Competitive enzyme-linked immunosorbent assay – Vaccine – Virus neutralisation – Virus.

Introduction

In areas infected with bluetongue (BT) virus (BTV), mortality and livestock movement restrictions cause considerable economic losses. The Italian Ministry of Health has implemented a compulsory BT vaccination campaign since May 2001. In an attempt to reduce direct losses due to disease and indirect losses due to virus circulation, the campaign has been conducted in infected and in adjacent areas and includes all susceptible domestic ruminants. During the first year of the campaign, Sardinia vaccinated 98.6% of the total sheep and goat population and 88.1% of the cattle population using a monovalent modified-live vaccine against BTV serotype 2 (BTV-2), manufactured by Onderstepoort Biological Products (OBP) in South Africa. It was the first time that the monovalent BTV-2 vaccine had been used in cattle and thus no information on its use in this species was available. Therefore, the primary aim of this study was to monitor the antibody response in cattle following vaccination under both field and controlled conditions. Acquired colostral immunity in calves is an outcome of vaccination; to design the vaccination campaign programme effectively, it is thus fundamental to know how long this immunity persists in the calves. Determination of the duration of colostral antibodies in calves born from vaccinated dams was the second objective of this study.

Materials and methods

The monovalent BTV-2 modified-live vaccine was produced by OBP in South Africa. Two groups of animals were used in this study. To monitor antibody response under field conditions, 1 005 cattle of various breeds and ages were selected at random from 10 herds in the Sardinian province of Oristano. Five cows were selected and kept in the security unit of the Istituto Zoopropfilattico Sperimentale dell'Abruzzo e del Molise (IZSA&M) to monitor their serological response to vaccination in a controlled environment. Between July and August 2002, both groups were vaccinated subcutaneously with 1 ml of 10^4TCID_{50} BTV-2 modified-live vaccine. Blood samples were taken from all animals monthly for three months thereafter. To assess duration of colostral antibodies, blood samples from 47 calves born from vaccinated dams were taken periodically. Based on their age at the time they were bled, the calves were divided into three groups: Group A included 22 calves 1 to 25 days old, Group B comprised 13 calves aged 26 to 39 days and Group C had 12 calves aged 40 to 60 days. Serum samples were tested for the presence of antibodies against BTV using a competitive enzyme-linked immunosorbent assay (c-ELISA) (VMRD, USA) and a virus neutralisation (VN) test (1). Positive and negative controls for the VN test were kindly provided by the Onderstepoort Veterinary Institute (OVI) (OIE Reference Laboratory), South Africa. The serological data were analysed using the Beta $(s+1, n-s+1)$ distribution where s, the number of successes, is the total number of positives and n, the number of trials, is the total number of tested animals. The peak of the distribution represents the most probable value of the percentage of positive animals and the distribution provides information about the uncertainty of the estimates due to sample size

Results

Of the 1 005 animals vaccinated with monovalent BTV-2 modified-live vaccine under field conditions, 994 (98.1%) were positive for antibody against BTV using the VN test and c-ELISA, while 11 (1.09%) did not develop measurable BT antibody levels. BTV-2 antibodies were detected in all cows vaccinated under experimental conditions. High VN titres were observed in both groups. The experimental group had the highest peak antibody response one month post vaccination (pv), whereas in the field group, the highest titres were observed two months pv (Fig. 1). VN antibody titres detected in the animals vaccinated under field conditions are shown in Figure 2 while the distribution of the percentages of positive animals is displayed in Figure 3. When re-vaccinated after a year, the 11 animals that had previously been found serologically negative, developed neutralising antibody titres.

BT antibody was detected in calves in Groups A and B (68.2% and 46.1%, respectively), whereas the calves in Group C were serologically negative. Figure 4 illustrates the distribution of the percentage of positive calves according to age at the time blood was taken.

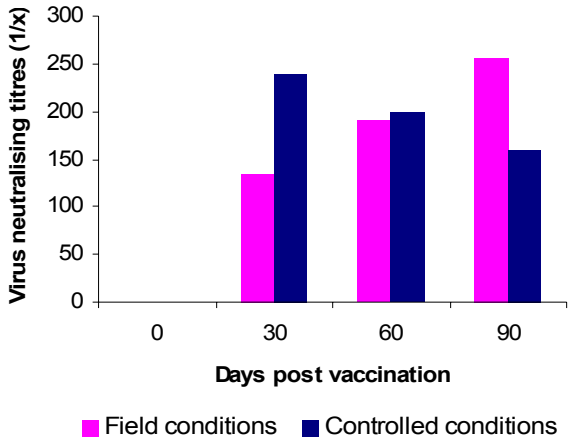

Figure 1
Mean of the virus neutralising antibody titres in cattle vaccinated with monovalent bluetongue virus serotype 2 modified-live vaccine under controlled and field conditions

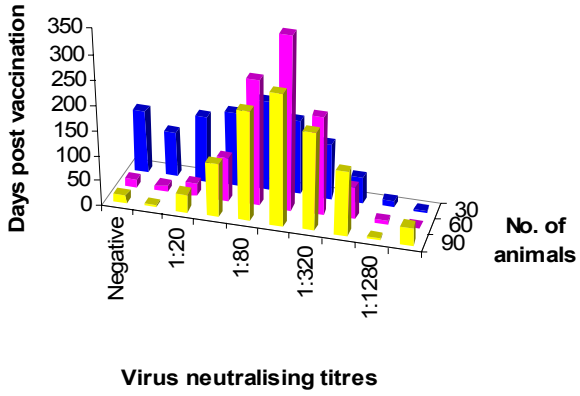

Figure 2
Virus neutralising antibodies in cattle vaccinated with monovalent bluetongue virus serotype 2 modified-live vaccine under field conditions
(n = 1 005)

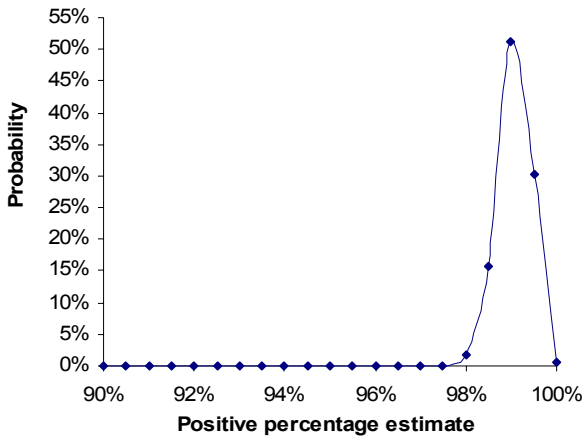

Figure 3
Distribution of the percentage of cattle with virus neutralising antibodies following vaccination with monovalent bluetongue virus serotype 2 modified-live vaccine under field conditions
(n = 1 005)

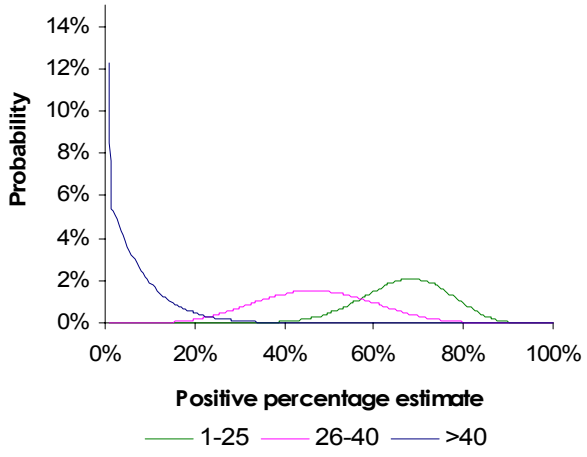

Figure 4
Distribution of the percentage of calves with virus neutralising colostral antibodies and grouped according to age
Group C showed no neutralising antibodies
(n = 47)

Discussion

As previously mentioned, most, if not all, of the information available concerning the use of the BT modified-live vaccine discusses only the application in sheep. Modified-live virus vaccines are produced by adapting BTV field isolates *in vitro* through serial passages in tissue culture or in embryonating chicken eggs. This process selects viruses that have a predilection for *in vitro* propagation and a reduced capacity to replicate *in vivo* and to cause disease. According to the literature, modified-live vaccines are effective in controlling clinical outbreaks of BT in endemic areas and in the face of outbreaks. If the vaccine virus retains an appropriate balance between attenuation of virulence and ability to replicate, the antigenic stimulus provided by its replication will elicit complete protection against challenge with virulent homologous virus and no clinical disease will develop. In this study, all animals exhibited an antibody response after being vaccinated twice with the BTV-2 modified-live vaccine; indeed a very high percentage (98.9%) developed antibody after a single vaccination. The neutralising antibody titres in the vaccinated cattle were similar to those observed in sheep (3). According to the beta distribution, based on the positive animals in this study, one injection of the BTV-2 modified-live vaccine in cattle is capable of producing VN antibodies in at least 98.2% of animals, with a confidence level of 95%. Since it has been demonstrated that protective immunity in BT is generally associated with the presence of type-specific neutralising antibodies (4), it can be concluded that the use of a monovalent BTV-2 modified-live vaccine in cattle will stimulate protection in almost all animals.

The second objective of this study addressed another important topic which has practical consequences. Knowing how long colostral immunity lasts in calves is crucial for livestock movement purposes in order to establish the age at which calves should be vaccinated. In lambs born to immune ewes, colostral immunity may last six months, during which time they are refractory to immunisation (2). In this study, no neutralising antibodies were found in calves older than 40 days. Due to the small number of animals tested, the probability curves were very wide and, for the oldest group of animals, the lower and upper prevalence levels were 0.2% and 21% (95% confidence level), respectively. Consequently, in calves older than 40 days, the prevalence of BT antibody-positive animals is lower than 21% with a confidence level of 95%.

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