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Original Article

Adverse reactions to bivalent vaccine against foot-and-mouth disease in beef and dairy cattle

Reações adversas à vacina bivalente contra a febre aftosa em bovinos de corte e leite

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Abstract

This study aimed to evaluate adverse reactions to the bivalent foot-and-mouth disease (FMD) vaccine in beef and dairy cattle. A non-probabilistic intentional sample of 98 animals was evaluated: 48 dairy cattle (3–11 years old) and 50 beef cattle (18–22 months old; 23 males and 27 females), all clinically healthy and without previous cervical lesions. Observations were performed on days 0 (pre-vaccination), 15, 30, and 45 post-vaccination, through clinical inspection and palpation, with measurement of nodules, when present, using a caliper and/or measuring tape. Data were analyzed using Pearson's Chi-square test (p<0.05). Local vaccine reactions were recorded in 20.4% (20/98) of animals, occurring significantly more often in dairy cattle (33%) than in beef cattle (8%). Among dairy cattle, 56.3% (9/16) of those with abscesses were approximately 10 years old. Animals that developed lesions at the first evaluation maintained them throughout the study period. No weight loss was associated with vaccine reactions. In conclusion, although the bivalent formulation reduces adverse effects, abscess formation may still occur, highlighting the need for monitoring and the adoption of good vaccination practices.

Keywords: abscess formation, local inflammatory response, beef cattle, dairy cattle, sanitary defense.

Resumo

Objetivou-se avaliar reações adversas decorrentes da aplicação da vacina bivalente contra febre aftosa em bovinos de corte e leite. Para isso, realizou-se estudo com amostragem não probabilística intencional, envolvendo 98 animais vacinados: 48 bovinos leiteiros (3 a 11 anos) e 50 bovinos de corte (18 a 22 meses; 23 machos e 27 fêmeas), todos clinicamente saudáveis e sem lesões prévias na região cervical. As observações ocorreram nos dias 0 (pré-vacinação), 15, 30 e 45 pós-vacinação, por meio de inspeção clínica e palpação, com mensuração dos nódulos, quando presentes, utilizando paquímetro e/ou fita métrica. Os dados foram analisados pelo teste do Qui-quadrado de Pearson (p<0,05). Reações vacinais locais foram registradas em 20,4% (20/98) dos animais, sendo significativamente mais frequentes em bovinos leiteiros (33%) do que em bovinos de corte (8%). Entre os leiteiros, 56,3% (9/16) dos que apresentaram abscessos tinham aproximadamente 10 anos de idade. Os animais que desenvolveram lesões na primeira avaliação mantiveram-nas até o final do experimento. Não foi observada perda de peso associada às reações vacinais. Conclui-se que, embora a formulação bivalente reduza a ocorrência de efeitos adversos, a formação de abscessos ainda pode ocorrer, ressaltando a necessidade de monitoramento e da adoção de boas práticas de vacinação.

Palavras-chave: formação de abscesso, resposta inflamatória local, bovinos de corte, bovinos leiteiros, defesa sanitária.

1. Introduction

Brazil holds the largest commercial bovine cattle herd in the world with 224.6 million animals (Instituto Brasileiro de Geografia Estatística (IBGE, 2022). It is also the biggest beef exporter, since it sells to more than 151 countries (Pereira et al., 2019), besides presenting a quite expressive beef livestock sector in the agribusiness. It is so, because this activity has given relevant contributions to the Brazilian GDP (Felix and Nardi Júnior, 2019).

Foot and mouth disease is an animal health issue of global concern due to its high infectious and contagion degree among cattle, sheep, goats and other cloven-hoofed animals. This disease is caused by a viral agent belonging to family Picornaviridae, genus Aphthovirus, which is featured by high morbidity rates, and for being responsible for the death of young animals and for severe yield reduction in adult animals (Melo et al., 2020).

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In Brazil, vaccination against FMD has been systematically mandatory for decades, according to the general guidelines established by the Ministry of Agriculture through Normative Instruction No. 44 of October 2, 2007 (Brasil, 2007), except in states and regions already recognized as free from vaccination, following the geographic evolution of FMD-free zones officially established by the Ministry of Agriculture (Brasil, 2022; Brasil, 2023). The recent introduction of the bivalent vaccine, replacing the former trivalent formulation, represented an important advancement in the National Program for the Eradication and Prevention of Foot-and-Mouth Disease (PNEFA). This change reduced the dose from 5 mL to 2 mL and removed saponin as an adjuvant, aiming to minimize adverse reactions (Brasil, 2017; Brasil, 2018).

However, previous studies have reported that, even with the new formulation, side effects such as abscesses and local inflammatory reactions may still occur, mainly associated with oil-based adjuvants that induce granulomatous lesions (Veran, 2000; Robattini et al., 2020; Caetano and Santos, 2022). Although these reactions generally do not compromise overall animal health, they may cause economic losses in slaughterhouses due to carcass trimming and the need for additional management (Oliveira Júnior et al., 2023).

Despite the relevance of this issue, scientific gaps remain regarding the frequency and severity of adverse reactions to the bivalent vaccine in different production systems (beef vs. dairy) and across age groups. Few field studies have directly compared these variables, especially in the regional context of Northeastern Brazil, where family-based and small-scale livestock production is predominant.

Therefore, the present study aimed to evaluate adverse reactions to the bivalent FMD vaccine in beef and dairy cattle, assessing their frequency, severity, and potential implications according to production system, animal age, and management practices. This approach seeks to provide scientific evidence to support animal health programs and to improve vaccination strategies in diverse production systems.

2. Materials and Methods

2.1. Study design and location

A longitudinal and prospective experimental study with non-probabilistic intentional sampling was conducted to evaluate adverse reactions to the bivalent FMD vaccine in cattle. The research was carried out in Presidente Dutra County, Maranhão State, Brazil, an important cattle-producing region with 665 rural properties, 713 cattle owners, and a total herd of 67,930 animals (Brasil, 2020). The study was approved by the Ethics Committee on Animal Experimentation of the State University of Maranhão (protocol n. 0035/2021), in compliance with CONCEA Normative Resolution 2/2016.

2.2. Animal selection and inclusion/exclusion criteria

A total of 98 animals were included: 48 dairy cattle aged 3–11 years and 50 beef cattle aged 18–22 months (23 males and 27 females). All animals were clinically healthy and had no visible lesions at the vaccination site (left post-scapular region). Exclusion criteria comprised animals presenting pre-existing abscesses, systemic illnesses, or any conditions that could interfere with the assessment of vaccine reactions.

Animals that met the inclusion criteria were randomly selected within each farm group. This randomization sought to minimize potential selection bias, although the overall sampling was non-probabilistic due to logistical constraints and reliance on available farms with updated health registration and regular vaccination records. The sample size, while not based on a formal probabilistic calculation, was considered representative of local production conditions and consistent with similar field studies.

2.3. Vaccine and application

The bivalent FMD vaccine, containing inactivated antigens of Type O1 Campos and A24 Cruzeiro, was purchased from suppliers accredited by the official sanitary defense authority. Vaccines were stored at 2–8 °C, transported in isothermal boxes with recyclable ice, and handled according to the manufacturer's recommendations and the Handbook of Good Vaccination Practices (Gaspar et al., 2015). Vaccination was performed following the official calendar established by the Ministry of Agriculture and Livestock (MAPA).

Animals were vaccinated with properly sanitized and calibrated syringes using a 2 mL subcutaneous dose applied to the left cervical region. The procedures were conducted by farm workers under supervision, following routine management practices.

2.4. Post-vaccination observations

Animals were evaluated at four time points: day 0 (before vaccination), and 15, 30, and 45 days after vaccination. Clinical inspections included direct observation and palpation of the injection site to detect local inflammatory reactions or abscess formation. When reactions were observed, the lesions were measured with a caliper and/or measuring tape to determine nodule dimensions. Body weight was also recorded to monitor potential effects on growth performance.

2.5. Data analysis

All data were entered into an Excel database, organized, and tabulated. Descriptive statistics were calculated, and comparisons between groups (dairy vs. beef cattle) were performed using Pearson's Chi-square test in the free-access Statistica software, version 13.3. A significance level of $p < 0.05$ was adopted.

3. Results

A total of 98 cattle were evaluated: 48 dairy animals aged 3–11 years and 50 beef animals aged 18–22 months (23 males and 27 females). Post-vaccination nodules were observed in 20 animals (20.4%). The frequency of nodules differed significantly between groups, with 33.3% of dairy

cattle (16/48) and 8% of beef cattle (4/50) showing local reactions ($\chi^2 = 8.74$; $p = 0.003$) (Figure 1).

Among dairy cattle that developed abscesses, 56.3% (9/16) were approximately 10 years old, indicating greater susceptibility in older animals. No significant differences were observed between males and females in the beef group ($\chi^2 = 0.14$; $p = 0.70$).

Animals presenting abscesses at the first post-vaccination evaluation (day 15) remained affected throughout subsequent observations (days 30 and 45), with most lesions showing progressive enlargement (Figure 2).

Regarding weight, no significant differences were detected between cattle with or without vaccine reactions (Student's t test, $p = 0.41$). Both groups showed the expected weight gain for the evaluation period, indicating that local reactions did not negatively influence growth performance.

4. Discussion

The results of this study confirm that, although the new bivalent FMD vaccine formulation has reduced the occurrence of adverse reactions compared with the trivalent formulation, abscess formation may still occur, especially in dairy cattle. This finding is consistent with previous reports associating oil-based adjuvants with chronic inflammatory responses at the injection site (Robattini et al., 2020; Caetano and Santos, 2022).

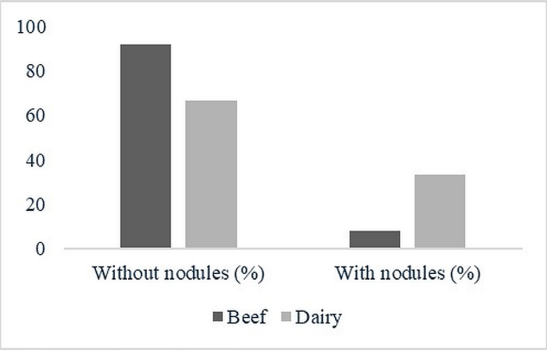

Figure 1. Occurrence of post-vaccine nodules in cattle subjected to vaccination against foot-and-mouth disease, Presidente Dutra County, Maranhão, Brazil, 2022. Observation between the 15th and 45th day after vaccination (in vivo).

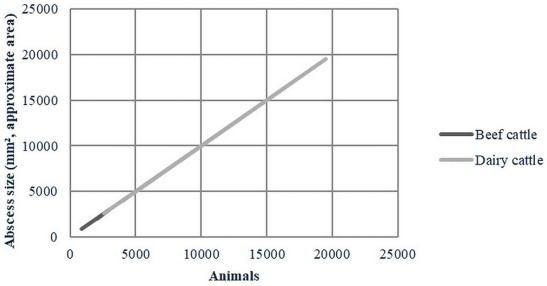

Figure 2. Dimension of post-vaccine abscesses observed in cattle subjected to vaccination against foot-and-mouth disease, Presidente Dutra County, Maranhão, Brazil, 2022.

The higher frequency of reactions in dairy cattle may be related both to the older age of these animals and to differences in management practices. Lima et al. (2014) reported that older cattle are more susceptible to post-vaccination nodules, possibly due to the cumulative number of vaccine doses received throughout life. In addition, restraint methods differ between production systems: beef cattle are usually handled in squeeze chutes, while dairy cattle are restrained in milking stalls. In older animals, this type of restraint may generate greater stress, which in turn may favor the development of local reactions.

From a practical perspective, even though reactions did not compromise weight gain in this study, their occurrence should not be underestimated. The presence of abscesses may negatively impact animal welfare, causing pain, discomfort, and stress during handling (Lima et al., 2014). Moreover, such lesions represent a relevant concern for carcass inspection, as they are a common cause of trimming or partial condemnation at slaughterhouses, resulting in economic losses for both producers and the meat industry (Caetano and Santos, 2022).

These findings reinforce the importance of continuous training in good vaccination practices, including proper animal restraint, disinfection of syringes and needles, correct subcutaneous application techniques, and adequate post-vaccination monitoring. Good agricultural practices, as described by Pereira and Souza (2022), are essential to ensure biosafety and to reduce the occurrence of adverse reactions during immunization procedures.

Guidelines from Embrapa have emphasized that the standardization of these procedures significantly reduces the occurrence of vaccine reactions (Gaspar et al., 2015). Therefore, farmer and worker training should be considered a central strategy to improve vaccine safety and minimize sanitary and economic losses. The implementation of management tools such as the PDCA cycle, as proposed by Santos et al. (2021), can further support the continuous improvement and standardization of vaccination processes in livestock production systems.

Finally, future studies should assess the impact of vaccine reactions not only on body weight but also on carcass quality and milk production, in addition to investigating strategies to mitigate such outcomes. Evaluations in different regions and production systems will further consolidate knowledge on the safety of the bivalent vaccine and support the strengthening of national animal health defense programs in Brazil

5. Conclusion

The results of this study demonstrate that adverse reactions can still occur following the administration of the bivalent FMD vaccine, even when good vaccination practices are applied. However, the frequency of reactions was lower compared to those previously reported with the trivalent vaccine, indicating that the new formulation represents an improvement in vaccine safety. Dairy cattle, particularly older animals, showed a higher susceptibility

to abscess formation, whereas beef cattle presented fewer local reactions. Importantly, no significant weight loss was associated with vaccine reactions, suggesting that these adverse effects did not compromise animal productivity in the evaluated period.

From a practical perspective, the findings highlight the need for targeted recommendations: proper restraint during vaccination, rigorous training of farm workers in vaccine administration, and systematic post-vaccination monitoring are essential measures to minimize local inflammatory responses. Special attention should be given to older dairy cattle, which appear to be more prone to adverse outcomes.

Overall, the study reinforces that while the new vaccine formulation reduces adverse effects, continuous surveillance and the adoption of best vaccination practices remain crucial for safeguarding animal health, maintaining consumer confidence, and supporting national sanitary defense programs.

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Data Availability Statement

The entire data set that supports the results of this study was published in the article itself.

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