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Post-Vaccination Monitoring of Foot and Mouth Disease (FMD) in Morowali Regency, Central Sulawesi

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Abstract

One of the main strategies for controlling Foot and Mouth Disease (FMD) in Indonesia is the implementation of a livestock vaccination program. Post-vaccination monitoring is essential to evaluate vaccine effectiveness and the overall success of the vaccination program as a basis for future FMD control policies. The evaluation of FMD vaccination outcomes in this study was conducted using the Enzyme-Linked Immunosorbent Assay (ELISA) technique. ELISA was applied to detect antibodies against the FMD virus in post-vaccination livestock serum samples. The Non-Structural Protein (NSP) ELISA method was used to screen for antibodies indicative of exposure to the field FMD virus, as NSP antibodies are generally produced only following natural infection and are not induced by vaccination. The NSP-ELISA results from 24 serum samples showed that 16.67% (4 samples) were seropositive, while 83.33% (20 samples) were seronegative. NSP seropositivity indicates exposure to the field FMD virus, whereas the high proportion of seronegative animals suggests that most vaccinated livestock were not exposed to the virus under field conditions. These findings demonstrate that the FMD vaccination program in Morowali Regency, Central Sulawesi, plays an important role in preventing virus transmission and reducing field infection rates in livestock.

Keywords: ELISA NSP, Foot and Mouth Disease (FMD), vaccination, seroprevalence, livestock

Introduction

Foot and Mouth Disease (FMD) is a highly contagious viral disease affecting cloven-hoofed animals, including cattle, buffaloes, goats, sheep, and pigs. Indonesia experienced a re-emergence of FMD in April 2022 after maintaining FMD-free status for 32 years. Indonesia maintained FMD-free status from 1990 to 2021; however, this status was suspended in mid-2022 following the re-emergence of the disease (Sutawi *et al.* 2023). The outbreak caused substantial economic losses, particularly among cattle farmers, due to decreased milk and meat production, morbidity rates reaching up to 100%, and restrictions on the trade of animals and animal products (Xin *et al.*

2025; Putra *et al.* 2024).

Clinically, FMD is characterized by fever, vesicles, and erosive lesions in the oral cavity, including the mouth, tongue, gums, and nostrils. Similar lesions may also occur on the hooves, teats, and hairless areas of the body. These symptoms cause infected animals to experience difficulty in chewing, feeding, and locomotion, leading to progressive deterioration and delayed recovery. Cattle represent the most affected species, accounting for approximately 94–99% of reported cases during 2022–2023. This high prevalence is likely related to the larger cattle population compared to other susceptible species, as well as higher cattle movement associated with trade activities (Kedang *et al.* 2025).

Evaluation of FMD vaccination outcomes using ELISA is a widely applied laboratory method in immunology to assess immune responses and antibody expression. Structural Protein (SP) ELISA is used to determine post-vaccination antibody titers by detecting antibodies against viral structural proteins in serum samples. This technique provides an indication of the immune status of vaccinated animals and the level of protection induced by vaccination (Kumar et al., 2021).

Antibody titers reflect the level of specific antibodies against FMD virus in the animal's body and indicate how effectively vaccination stimulates the immune system. Higher antibody titers are associated with better protection against FMD virus infection. Therefore, post-vaccination monitoring through antibody titer measurement serves as an important indicator of vaccination program success. Effective FMD control relies on accurate, reliable, and scientifically sound diagnostic testing. Diagnostic approaches include serological tests such as ELISA and antigen detection methods, including real-time PCR, conventional PCR, and sequencing. The primary FMD control strategy implemented by the Indonesian government is vaccination, accompanied by movement control and market closures in high-risk areas. Vaccines consist of attenuated or inactivated antigens designed to induce protective immunity through antibody and memory cell formation. Vaccination is administered only to healthy cattle, including calves from two weeks of age. Animals in suboptimal health condition receive supportive treatment prior to vaccination.

Vaccination programs are conducted in accordance with the Decree of the Minister of Agriculture No. 517/KPTS/PK.300/M/7/2022, amending Decree No. 510/KPTS/PK.300/M/6/2022 on FMD control. Under this regulation, post-vaccination monitoring is carried out by veterinary authorities to ensure vaccination effectiveness. Post-vaccination monitoring is essential to evaluate vaccine performance and guide future disease control policies (Kharatyan et al., 2023). Detection of antibodies against structural (SP) and non-structural proteins (NSP) using ELISA allows assessment of vaccine-induced herd immunity and identification of field infection. NSP-ELISA is particularly useful for Differentiating Infected from Vaccinated Animals (DIVA). This study aimed to evaluate the efficiency of the FMD vaccination program in preventing, controlling, and managing FMD infection in livestock in Morowali Regency, Central Sulawesi. The findings are expected to provide scientific evidence to support future FMD control strategies and policy development.

Material and Method

Post-vaccination monitoring was conducted starting in June 2025. Serum samples were collected from cattle vaccinated against FMD in Morowali Regency, Central Sulawesi. Laboratory testing was performed at the Serology Laboratory of the Maros Veterinary Center. Serum and blood samples were used for antibody detection using the NSP-ELISA method. Materials included EDTA blood collection tubes, micro-serum tubes, cotton, 70% alcohol, 5-mL syringes, gloves, and ice packs.

The FMD vaccine used in this study was Aphtovet FMD. ELISA was employed to detect antibodies against viral proteins in post-vaccination serum samples. Antibody titers were used as indicators

of immune protection against FMD virus infection. Post-vaccination immune response monitoring aimed to assess herd immunity at the population level. Herd immunity is defined as the proportion of immune animals within a susceptible population and serves as an indicator of virus transmission potential. Antibody prevalence data were used to evaluate vaccination coverage in the target population.

Sample collection was accompanied by data on animal age, vaccination history, and FMD infection history. Serum samples were collected 1–3 months post-vaccination and analyzed at the Maros Veterinary Center.

Results and Discussion

The NSP-ELISA method was used to detect antibodies against non-structural proteins of the FMD virus, which are produced as a result of natural infection. In contrast, SP-ELISA O and A detect antibodies formed in response to vaccination. NSP proteins are absent from inactivated FMD vaccines; therefore, the presence of NSP antibodies serves as an indicator of natural infection. Testing was conducted at the Maros Veterinary Center Laboratory (Figure 1).

Table 1. Serological test results of livestock serum samples collected from Morowali Regency, Central Sulawesi, Indonesia

No.	Sampling Location	Sample Code	Sample Type	Value (%)	Test Result
1	Lantula Jaya, Wita Ponda, Morowali, Central Sulawesi	A1	Cattle serum	25.729	Seronegative
2	Lantula Jaya, Wita Ponda, Morowali, Central Sulawesi	A2	Cattle serum	49.013	Seronegative
3	Puntari Makmur, Wita Ponda, Morowali, Central Sulawesi	A3	Cattle serum	28.882	Seronegative
4	Puntari Makmur, Wita Ponda, Morowali, Central Sulawesi	A4	Cattle serum	49.488	Seronegative
5	Limbo Makmur, Bumi Raya, Morowali, Central Sulawesi	A5	Cattle serum	47.463	Seronegative
6	Limbo Makmur, Bumi Raya, Morowali, Central Sulawesi	A6	Cattle serum	96.253	Seropositive
7	Marga Mulya, East Bungku, Morowali, Central Sulawesi	A7	Cattle serum	44.86	Seronegative
8	Marga Mulya, East Bungku, Morowali, Central Sulawesi	A8	Cattle serum	38.45	Seronegative
9	Marga Mulya, East Bungku, Morowali, Central Sulawesi	A9	Cattle serum	12.954	Seronegative
10	Wosu, East Bungku, Morowali, Central Sulawesi	A10	Cattle serum	46.211	Seronegative
11	Wosu, East Bungku, Morowali, Central Sulawesi	A11	Cattle serum	96.629	Seropositive
12	Wosu, East Bungku, Morowali, Central Sulawesi	A12	Cattle serum	12.617	Seronegative
13	Wosu, East Bungku, Morowali, Central Sulawesi	A13	Cattle serum	95.446	Seropositive

No.	Sampling Location	Sample Code	Sample Type	Value (%)	Test Result
14	Wosu, East Bungku, Morowali, Central Sulawesi	A14	Cattle serum	30.827	Seronegative
15	Lantona, Central Bungku, Morowali, Central Sulawesi	A15	Cattle serum	42.533	Seronegative
16	Lantona, Central Bungku, Morowali, Central Sulawesi	A16	Cattle serum	8.573	Seronegative
17	Lantona, Central Bungku, Morowali, Central Sulawesi	A17	Cattle serum	96.258	Seropositive
18	Lantona, Central Bungku, Morowali, Central Sulawesi	A18	Cattle serum	48.656	Seronegative
19	Kolono, East Bungku, Morowali, Central Sulawesi	A19	Cattle serum	28.095	Seronegative
20	Kolono, East Bungku, Morowali, Central Sulawesi	A20	Cattle serum	47.395	Seronegative
21	Bahomoh, East Bungku, Morowali, Central Sulawesi	A21	Cattle serum	16.349	Seronegative
22	Bahomoh, East Bungku, Morowali, Central Sulawesi	A22	Cattle serum	31.451	Seronegative
23	Le Le, Bahodopi, Morowali, Central Sulawesi	A23	Cattle serum	41.593	Seronegative
24	Le Le, Bahodopi, Morowali, Central Sulawesi	A24	Cattle serum	30.515	Seronegative

The serological analysis of 24 livestock serum samples collected from Morowali Regency, Central Sulawesi, revealed varying antibody responses across sampling locations. were obtained from multiple subdistricts, including Wita Ponda, Bumi Raya, Bungku Barat, Bungku Tengah, Bungku Timur, and Bahodopi.

Overall, four samples (16.67%) were classified as seropositive, while the remaining 20 samples (83.33%) were seronegative. This high prevalence of seronegative results suggests limited circulation of the field virus in the study area during the sampling period. Additionally, the predominance of seronegative findings among vaccinated animals may reflect the effectiveness of vaccination and disease control measures implemented in Morowali Regency.

Differences in serological status among sampling locations may be influenced by variations in animal movement, biosecurity practices, and local husbandry systems. The detection of seropositive animals in specific villages highlights the importance of continued serological surveillance to identify potential foci of infection and to support targeted control strategies. Overall, the findings indicate that field virus exposure was relatively low and sporadic, supporting the effectiveness of ongoing disease prevention efforts in the region (Nthiwa *et al*, 2020)

The NSP-ELISA results showed that 16.67% (4/24) of serum samples were seropositive, while 83.33% (20/24) were seronegative. NSP antibody detection is useful for identifying subclinical FMD infection, as NSP antibodies persist longer in cattle compared to SP antibodies and serve as markers of field virus exposure (Mohapatra et al., 2011).

NSP-positive results indicate prior exposure to the field FMD virus, whereas NSP-negative results suggest absence of infection following vaccination. Animals infected with FMD virus produce both NSP antibodies, indicating infection, and SP antibodies associated with immunity against specific viral serotypes (Sari et al., 2023).

Laboratory confirmation of suspected FMD involves detection of viral material or antibodies against SP and NSP in serum samples. SP-based detection alone cannot distinguish infected from vaccinated animals; therefore, NSP-ELISA enables the Differentiating Infected from Vaccinated Animals (DIVA) approach by identifying NSP antibodies in infected animals (Wong et al., 2020). Animals previously infected with FMD virus typically show seropositive results for both NSP and SP antibodies, whereas vaccinated but uninfected animals are NSP-negative and SP-positive (Azimi *et al.* 2023). In this study, only 4 out of 24 animals showed evidence of field virus exposure. The high proportion of NSP-negative animals (83.33%) indicates that most vaccinated cattle were protected from field exposure to the FMD virus.

Conclusion

The FMD vaccination program implemented in Morowali Regency, Central Sulawesi, demonstrated good effectiveness in preventing exposure to the field FMD virus. This was evidenced by NSP-ELISA results showing that 83.33% of vaccinated cattle were NSP-seronegative, indicating the absence of post-vaccination field infection. Therefore, FMD vaccination plays a crucial role in the prevention, control, and mitigation of FMD in livestock.

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