



Effects of *Curcuma longa* L. on antibody titer and body weight of sheep post vaccination for house and mouth diseases

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Abstract

Foot and mouth disease (FMD) is an acute and highly contagious viral infectious disease in even/split-hoofed animals and some wild animals. Diseases of the mouth and hoof can cause significant economic losses due to declining production and become an obstacle to the trade in animals and their products. FMD causes much harm to infected animals, one of which is weight loss. Vaccination is the most critical factor in the control of FMD, and the type and quality of vaccines available play an essential role. However, immunomodulators are also needed to increase the immune response to the current FMD vaccine. It is reported that administering *Curcuma longa* to experimental animals could increase body weight gain and immunity by increasing antibody titers. Therefore, this article will review the immunomodulatory properties of *Curcuma longa* about FMD infection.

Keywords: Antibody titer, body weight, foot and mouth disease, vaccination

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Introduction

Foot and mouth disease (FMD) is an acute and highly contagious viral infectious disease in even/split-hoofed animals and some wild animals. Diseases of the mouth and hoof can cause significant economic losses due to declining production and become an obstacle to the trade in animals and their products. The formation of vesicles/blisters and erosion in the mouth, tongue, gums, nostrils, nipples, and skin around the nails characterizes this disease. Foot and mouth disease is caused by foot and mouth virus (FMDV) of the genus Aphthovirus, family Picornaviridae, and consists of seven serotypes, namely C, O, A, SAT1, SAT2, SAT3, and Asia1 (Abdullah et al., 2020). FMD is endemic in parts of Asia, while Australia, Japan, New Zealand, the Philippines, Singapore, New Caledonia, Brunei, and Vanuatu are currently free of PMD. However, FMD is a cross-border animal disease that can occur sporadically in any region currently free of the disease. Indonesia was declared a PMK-free country

in 1986 through the Minister of Agriculture No.260/ Kpts/ TN.510/5/1986 decree and later recognized by OIE as stated in OIE Resolution Number XI of 1990 (Kementan, 2022). However, in April 2022, foot and mouth disease reemerged and became an epidemic in Indonesia after the first cases reported were found in East Java and Aceh provinces; then, the outbreak of hoof and mouth disease expanded to livestock centers in Indonesia.

FMD control efforts must be directed at early infection detection and rapid treatment. Intervention strategies for controlling FMD include culling susceptible animals, limiting movement, and vaccination. The type of vaccine used in Indonesia is an inactive vaccine, which is compatible with the FMD virus serotype circulating in Indonesia based on the results of a vaccine matching test and received a recommendation from the National Veterinary Authority Official (Kementan, 2022). Increased adjuvants or additional molecule costimulators can significantly

increase the induction of early protection and long-term immunity from vaccines. Therefore, there is a need for immunomodulators to increase the immune response to the current FMD vaccine (Singh et al., 2019). The use of natural medicines/herbal products is an alternative in future veterinary treatment. Herbal products are safe, cheap, and have minimal undesired side effects. According to WHO (World Health Organization), herbal products are the best source for obtaining various medicines and active compounds. Turmeric is a herbal product that is widely used and has been proven to have antioxidant, anti-inflammatory, anticancer, hepatoprotective, antifungal, antihypertensive, neuroprotective, and immunomodulatory effects (Saho et al., 2020).

Foot and Mouth Diseases

Foot and Mouth Disease (FMD) is the most feared infectious animal disease in the world because it causes enormous economic and social losses. Foot-and-mouth disease is endemic in South America, Africa, Asia, and Europe. This disease is characterized by vesicles in the mouth, nails, and nipples, and this virus causes the body of the affected animal to become weak. This impact causes very high expenditure on medicines and animal care. Another disadvantage is that disease-free countries refuse to import livestock and livestock derivative products from endemic countries and those affected by FMD (Rodriguez et al., 2020). Foot and Mouth disease is caused by the Foot and Mouth Disease virus (FMD VIRUS) belonging to the Picornaviridae family and the Aphtovirus genus.

Foot and mouth disease in goats and sheep tends to be mild, and most are asymptomatic or have lesions in only one location. The common signs in small ruminants are mild to severe fever, lameness of one leg or more, and vesicles on the hooves like in cattle, but they can burst and hide when walking. Oral lesions are often not visible and generally appear as superficial erosions. Vesicles may also be seen on the nipples and rarely on the vulva or prepuce. Milk production can decrease,

and male goats/sheep may be reluctant to mate, and female goats/sheep experience abortions (Center for Food Security and Public Health, 2021).

FMD is an airborne disease, and the respiratory tract is the main route of infection. The viruses exist in the droplets of the saliva of coughing or sneezing animals; mostly have infected pigs, cattle, and sheep. High infectivity indices have been found in aerosols from milk and feces (Barlow, 2016). The virus can also enter through the oral cavity by mechanical transmission through infectious nasal secretions (nose-to-nose contact) or in saliva (by licking or shared use of contaminated utensils: watering and through cutlery, among others). Unexpected risks occur if the virus enters through the skin/skin folds (such as interdigital areas) because intact skin has active mechanisms related to its acidic pH, the presence of antibacterial fatty acids, and normal flora, making the skin able to resist various pathogenic aggressions (Rodriguez et al., 2020). The FMD virus attaches to host cells by recognizing receptors on the cell surface and then enters the host cell through receptor-mediated endocytosis. FMD virus is the only virus from the Picornaviridae family that can use four integrin receptors ($\alpha\beta1$, $\alpha\beta3$, $\alpha\beta6$, and $\alpha\beta8$) to mediate infection (Wang et al., 2015). The role of $\alpha\beta6$ as a cell receptor suggests that the expression of this integrin is restricted to epithelial cells (targets of FMD virus infection) located in the epithelium of the upper airways, oral cavity, gastrointestinal tract, and foot coronary bands (Rodriguez et al., 2020).

Eradication Strategy

Three basic principles for eradicating FMD outbreaks are (1) Prevent contact between susceptible animals and the FMD virus, (2) Prevent the spread of the FMD virus from infected animals, and (3) Increase the immunity of susceptible animals. These principles can be applied by (1) Stopping the spread of viral infections through quarantine measures and traffic control, (2) Eliminate the source of infection by culling infected animals and exposed animals (stamping

out); (3) Eliminate the FMD virus by decontaminating cages, equipment, vehicles and other materials that may transmit the disease; or disposal of contaminated materials; and (4) Establishing immunity in susceptible animals by vaccination (Dirjen Peternakan, 2022).

In implementing vaccination, achieving a certain minimum level of immunity in the population (herd immunity) is essential. The proportion of the population that needs to be protected to achieve immunity depends on several factors, including population density and contact network (densely populated areas or there is much mixing will require higher vaccination rates), previous exposure to the FMD virus, previous vaccination, or the presence of maternal antibodies. In general, herd immunity that must be achieved is 80% of the total population. However, the fact is that not all vaccinated animals will respond well to the vaccine, and there may be problems in the vaccine delivery process (OIE & FAO, 2021). Therefore, immunomodulators are needed to increase the immune response to the FMD vaccine.

***Curcuma longa* and Antibody**

Turmeric (*Curcuma longa*) is a type of traditional medicinal plant widely used worldwide. *Curcuma longa* is one of the largest genera in the Zingiberaceae family, and there are around 100 other species of *Curcuma* (Dosoky & William, 2016). The rhizomes of this plant are widely used in traditional medicine (antioxidant, anti-inflammatory, anti-diabetic, hepatoprotective, and anti-carcinogenic) and as a spice in cooking, food flavoring, coloring, cosmetics, and fragrances. *Curcuma longa* Linn (syn. *Curcuma domestica* Val.) is a plant native to tropical South Asia. However, it can be found throughout tropical regions (Li et al., 2011), such as Cambodia, China, India, Nepal, India, Madagascar, Malaysia, Philippines, and Vietnam (Yadav & Tarun, 2017).

Various studies have shown that curcumin, a compound found in turmeric, can have various effects on livestock. In Hu sheep (Local Chinese sheep), curcumin

supplementation in food can improve lipid metabolism, antioxidant status, reproductive performance, and immunity by increasing IgA, IgM, and IgG concentrations in plasma (Zhiyang et al., 2019). As a feed additive for lactating sheep, curcumin improves antioxidant performance and the immune system (Molosse et al., 2018). In vitro research conducted by Pauletto et al. (2020) revealed that the use of curcumin reduces Aflatoxin B1-induced liver toxicity related to antioxidant responses, defense and inflammatory responses, cancer, drug metabolism, and drug transport in cattle. Phytochemical analysis revealed that *C. longa* contains more than 235 compounds, especially polyphenols and terpenoids. The leading group of polyphenols is curcuminoids (80% curcumin), demethoxycurcumin, and bisdemethoxycurcumin (Li et al., 2011).

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turmeric flour per cow for ten days in dairy cows can increase immunity and prevent subclinical mastitis (Rathaur et al., 2020). In addition, using 4% turmeric flour and 4% capsicum as much as 0.125 g/Kg in pig food increased the FMD vaccine antibody titer, reduced the vaccine's adverse effects, and increased body weight (Upadhaya et al., 2020). Antibody titer is a type of blood test used to determine the presence and level of antibodies in the blood. The importance of persistently high levels of specific antibody titers is that they can give protection much longer when vaccinated subjects achieve neutralizing antibody titers higher than the recommended values Esposito & Nicola (2018).

***Curcuma longa* and Body Weight**

Balinese cows given concentrated supplementary feed with 1.5% *Curcuma longa* (turmeric) flour can increase body weight gain by 38.24%, FCR by 47.20%, and so provide farmers benefits (Budiari et al., 2020). Another study in Bali cattle that were given additional concentrated feed and probiotic-turmeric up to 15 ml/head/day resulted in weight gain of 0.76 kg/head/day, an increase of 52.00% compared to cattle that were not given probiotic-turmeric (0.50 kg/head/day).

Research conducted by Akhadiarto (Akhadiarto Rofiq, 2008) states that there is an increase in the weight of newly calving sheep when the food is mixed with *Curcuma longa* flour. Bodyweight increase is likely due to the positive effect of turmeric flour content that affects the condition of the rumen so that microbial activity increases, which will further increase the digestibility of the ration, and then the weight gain increases as well.

The increase in animal body weight is likely due to the antioxidant effect. Sugiarto et al. (1986) suggested that curcumin can maintain the integrity of microbial cells. *Curcuma longa* contains natural antioxidants that can protect and maintain microbial cell membranes from damage caused by free radicals. This property allows microbial cells to be more active in digesting food. The more food that is digested, the more nutrients will be

absorbed by the body, which will increase the animal's body weight.

Conclusion

Based on the review, it can be concluded that *Curcuma longa* can increase immunity by increasing antibody titers. The antioxidant effect of *C. longa* can also increase the body weight of experimental animals. Therefore, it is recommended that *C. longa* be added to the animal feed as an immunomodulator to prevent further damage due to infectious diseases such as FMD.

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