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Foot and mouth disease: the current scenario of control strategies

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Abstract
Foot and mouth disease (FMD) is a globally important livestock disease causing an economic havoc. Much of the research was done and ongoing for control. In this article we described about the current scenario of FMD control in India, the conventional vaccines available and modern alternative strategies being in research for control of FMD. The world has taken its step forward in control of FMD with an effective vaccination strategies.

Keywords: FMD, control strategies, vaccination, VLP, thermostability

1. Introduction
Foot and mouth disease (FMD) is the most contagious viral disease caused by FMD virus that belongs to genus *Aphthovirus* of family *Picornaviridae* [1]. The infection is caused in more than 70 species of wild and domestic cloven hoofed animals [2]. The virus consists of single stranded positive sense RNA of approximately 8.5 Kb encapsidated in an icosahedral capsid. Each of the four structural proteins, 1A, 1B, 1C and 1D assemble to form a protomer, 5 protomers assemble to form a pentamer, 12 pentamers assemble to form a whole capsid [3, 4] and hence each capsid consist of a total of 60 copies of four structural proteins. The virus exists in seven serotypes *viz.*, O, A, C, Asia 1, SAT 1, SAT 2, and SAT 3 as well as numerous variants and lineages described as genotypes [5, 6]. As of now no cross protection between the serotypes is noticed. The virus involved in an outbreak cannot be differentiated in between serotypes on the basis of clinical signs [7]. The seven serotypes are randomly distributed across the world. Serotype O is the most prevalent of all serotypes, especially in Asia, followed by serotypes A and Asia 1 [8]. The disease plays an important role in global trade and is a priority disease among the list A diseases published by Office International des Epizootics [9].

2. Current scenario and control strategies
India being mostly dependant on agriculture sector has more than 500 million FMD susceptible livestock species experiencing the loss of more than Rs.20000 crores/annum directly and even much more indirectly [10]. Currently, the most effective methods in slowing down the spread of the disease through livestock population include, restricting the movement of animals and animal products, slaughter of infected and exposed animals, disinfection of premises and vaccination of the susceptible population using a killed FMD virus based vaccine. The government of India initiated FMD control along with programmes such as sero monitoring and surveillance, and a six month vaccination programme headed by Central FMD laboratory at Mukteswar [11].

3. Global advances in FMD vaccine world
Although conventional inactivated vaccines play a vital role in current FMD control, their disadvantages have become apparent in recent years. For instance, the virus sometimes escapes from vaccine production facilities and has caused FMDV infections in vaccinated animals due to incomplete inactivation [12, 13]. Further, it is not possible to distinguish carrier animals from uninfected vaccinated animals [12]. Therefore, to overcome the limitations of the conventional inactivated vaccine, there is a need to develop novel vaccines such as recombinant subunit vaccines, synthetic peptide vaccines, and virus like particle (VLP) vaccines (12, 14-6) for effective control of FMD. One of the most promising candidates is VLP vaccines, mainly due to their similarity in antigenic and immunogenic properties with their natural FMDV counterparts but are non-infectious since they do not contain viral genome [17].

Insect cell based expression systems are widely used for VLP production in the laboratory or on an industrial scale due to a number of advantages, such as the fast growth rates in animal product free media, the capacity for large scale cultivation and the ability to post-translationally modify the recombinant proteins similar to mammalian cells [18]. Although an insect cell baculovirus expression system was reported for the production of FMDV serotype O VLPs [15, 19-21], related reports showed that the FMDV serotype O viral capsid was more temperature and acid sensitive than the other types and showed poor antigen quality [21, 22]. Based on thermodynamic study on Molecular Dynamic (MD) simulations, the mutation at 93 residue of VP2, a part of α-helix adjacent to icosahedral two fold axis seems to improve the stability of an empty capsid [23].

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