Efficacy of Simultaneous Vaccination of Piglets Against Foot and Mouth Disease and Classical Swine Fever

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Keywords: Classical swine fever, Foot and mouth disease, Vaccine

Introduction
Foot and mouth disease (FMD) is a highly contagious disease of cloven-hoofed animals. The causative agent of FMD is foot and mouth disease virus (FMDV), which belongs to the family Picornaviridae. The devastating outbreak of FMD in Taiwan in 1997 resulted in depopulation of more than 3.85 million pigs and direct financial losses of 400 million US dollars (3). Classical swine fever (CSF), also known as hog cholera, is an important disease of swine. This disease is caused by classical swine fever virus (CSFV), which belongs to the family Flaviviridae (4). CSFV consists of only one serotype. In Taiwan, CSF is controlled by performing vaccination with a live vaccine strain called Lapinization Philippine Coronel (LPC) (4). The blanket vaccination, either against FMDV or CSFV, needs lots of man-power; however, the shortage of man-power is very common in pig farms of Taiwan. Moreover, the vaccination always increases the stress to pigs. Because of these reasons, farmers ask for the solution to reduce both the needs of man-power for vaccination and the stress to pigs caused by vaccination (1). To address this issue, the efficacy of simultaneous vaccination of pigs against FMD and CSF is evaluated in this report.

Materials and Methods
Animals and vaccines: Ten-week-old unvaccinated piglets born to regularly vaccinated sows were used in this study. Twenty-six piglets were divided into four test groups and one control group. The test groups contained six piglets whereas the control group contained only two piglets. Piglets of different groups were housed in different isolated units. Test group 1 was vaccinated with 1 mL (1 dose) of double emulsified FMD vaccine (O1 Campos strain). Test group 2 was vaccinated with 1 mL (1 dose) of live CSF vaccine (LPC strain). The vaccination in groups 1 and 2 was conducted by intramuscular injection at the neck behind the left ear. Test group 3 was simultaneously vaccinated with 1 dose of FMD and 1 dose of CSF vaccine by intramuscular injection at the neck behind the left and right ear, respectively. Test group 4 was vaccinated with 2 mL of mixed FMD and LPC vaccine, each of which contained 1 dose of vaccine. The mixed vaccine was prepared by mixing an equal volume of FMD and LPC vaccines using two syringes connected by a three-way stopcock for 5 minutes. The mixed vaccine was then intramuscularly injected at the neck behind the left ear soon after its preparation.

Neutralization antibody titers against FMDV and CSFV: Serum neutralization (SN) test was performed using BHK-21 grown on microtiter plate according to the method described by Donaldson et al. (2). Serum neutralization test against CSFV was performed using PK-15 cells (5). The neutralization antibody titers were compared using the Generalized Linear Model (GLM) procedure of SAS software.

Results and Discussion
Neutralization antibody titers against FMDV: To compare antibody responses to FMDV between piglets of groups 1, 3, 4, and 5, the geometric mean of reciprocal antibody titers of each group was calculated and shown in Fig. 1. The results showed that at two weeks post the primary vaccination, group 3 had the highest antibody titers, but there was no significant difference (p>0.05) between the three vaccinated groups. At four weeks post the primary vaccination, the antibody titers of all vaccinated groups dropped, and group 3 had highest antibody titer, but there was still no significant difference (p>0.05) between vaccinated groups. At two weeks post the boost vaccination, group 1 had highest antibody titer, but there was still no significant difference (p>0.05) between the three vaccinated groups. Note that the low antibody titers observed in groups 3 and 4 at two weeks post the boost vaccination appeared to result from piglets containing maternal antibody. All control piglets (group 5) remained sero-negative throughout the period of experiment. In conclusion, no significant difference was observed between the three vaccinated groups after the primary and boost vaccination. Therefore, the antibody response to FMDV was not significantly affected by simultaneous vaccination with CSFV.

Neutralization antibody titers against CSFV: To compare the antibody response to CSFV between piglets of groups 2, 3, 4 and 5, the geometric mean of reciprocal antibody titers of each group was calculated and shown in Fig. 2. The results showed that at two weeks post the primary vaccination all vaccinated group exhibited a relatively low of antibody titer (geometric means ≤ 1:20). In contrast, at four weeks post the primary vaccination the titers of all vaccinated groups increased to ≥1:38;
moreover, groups 3 and 4 had higher antibody titers than group 5, but the titer of group 2 was not significantly higher than group 5. At two weeks post the boost vaccination group 4 had higher antibody titers than groups 2 and 3, but there was still no significant difference ($p<0.05$) between vaccinated groups. All control piglets (group 5) had no antibody against FMDV throughout the experiment. In conclusion, no significant difference was observed between the three vaccinated groups after the primary and boost vaccination. Therefore, the antibody response to CSFV was not affected by simultaneous vaccination against FMDV. The challenge test showed that all vaccinated piglets remained healthy for at least 14 days after challenge with a virulent strain of CSFV. In contrast, the two unvaccinated piglets exhibited typical CSF symptoms at 5 and 6 days after the challenge and died at 9 and 10 days. Therefore, the resistance to CSFV was not affected by simultaneous vaccination with FMD. Blanket vaccination against FMD and CSF in pigs has been conducted in Taiwan since 1997 and 1958, respectively. These efforts have brought FMD and CSF under control and Taiwan has regained the FMD-free status with vaccination since May 2003. In Taiwan, FMD and CSF vaccines are normally administered by independent vaccination program. The separate vaccinations take more labor and add more stress to piglets vaccinated. Results from this study shows that simultaneous vaccination of piglets with FMD and CSF did not affect the antibody responses elicited by both vaccines. Moreover, all vaccinated piglets were resistant to infection of a virulent strain of CSFV. These results are consistent with findings reported by De Clercq et al. (1), but we showed additionally that FMD and CSF vaccines could be mixed and inoculated in a single spot. Moreover, the FMDV we used was a pig-adaptive strain O/Taiwan/97. These findings are new and useful for establishing a labor-saving program for vaccination of piglets against FMD and CSF.

It is known that maternal antibody might affect the antibody response to FMDV. Our work showed that piglets containing maternal antibody had lower antibody response to the FMDV vaccine, but a boost vaccination could bring the antibody titers of most piglets to the level ≥ 1:16, which is considered enough for protection. In contrast to the FMDV vaccine, our work showed that the maternal antibody of CSFV did not significantly affect the antibody response to the CSFV vaccine. Our result indicates that a maternal antibody ≤1:45 might not influence the efficacy of CSFV vaccine. This finding is consistent with the previous report by Suradhat et al. (6), who showed that the maternal antibody with the level ≤1:32 did not influence the efficacy of the CSFV vaccine whereas those with the level ≥1:64 did. Taken together, it appears that piglets with the maternal antibody level <1:64 are acceptable for vaccination against CSFV, either alone or together with the FMD vaccine.

References