NOTE *Virology*

Effect of vaccination with a modified live porcine reproductive and respiratory syndrome virus vaccine on growth performance in fattening pigs under field conditions

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ABSTRACT. Porcine reproductive and respiratory syndrome virus (PRRSV) has caused significant economic losses to the global swine industry. The present study aimed to evaluate the efficacy of a commercial PRRSV modified live virus (MLV) vaccine in conventionally reared growing/finishing pigs. Four barns were designated for groups A, B, C and D in the growing-to-finishing site. All pigs of the A barn were vaccinated with a commercial PRRSV MLV vaccine, whereas pigs of the B, C or D barn as control groups were unvaccinated. Twenty pigs randomly selected and tagged from each barn were serially bled at 0, 20, 40 and 60 day-post-vaccination, and tested for serological response with a commercial enzyme-linked immunosorbent assay kit. Body weights were measured to calculate the average-daily-weight gain (ADG). Serological assays indicated that the seropositivity of the PRRSV-vaccinated group was higher than that of the unvaccinated groups at 40 day-post-vaccination. ADG of group A was significantly higher than that of groups B and C, and the mean weights of groups A, B, C and D were 0.82 ± 0.017, 0.76 ± 0.016, 0.74 ± 0.019 and 0.81 ± 0.018 kg, respectively. In conclusion, the present study reports the serological responses and growth performance parameters by the PRRSV MLV vaccine in growing/finishing pigs under field conditions.
KEY WORDS: growing-finishing pig, growth performance, modified live virus vaccine, porcine reproductive and respiratory syndrome virus

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Porcine reproductive and respiratory syndrome virus (PRRSV) has caused significant economic losses (approximately US$664 million annually) to the United States swine industry and continues to affect the global industry [4]. PRRSV is a member of the family *Arteriviridae*, genus *Arterivirus* and is a small enveloped virus with a single-stranded RNA genome of approximately 15kb [9]. In general, PRRSV primarily infects alveolar macrophages in the lungs of pigs and can cause respiratory distress and reproductive failure in nursery and growing pigs and breeding-age pigs, respectively [1, 3]. To control PRRSV, the prevention of viral infection using modified live virus (MLV) vaccines or inactivated vaccines is currently considered as the main strategy [2, 10, 13].

PRRSV, which is one of the main pathogens resulting in porcine respiratory disease complex (PRDC), can achieve synergism with other respiratory bacteria or viruses even in vaccinated growing/finishing pigs [11]. Therefore, PRRSV control or elimination by vaccination is economically meaningful as slow growth rates and decreased feed efficiency due to persistent PRRSV infection represent additional production costs in growing/finishing pigs [7, 11]. Nevertheless, PRRSV vaccine efficacy studies conducted for the growth performance of growing/finishing pigs are rarely reported due to the fact that nursery pigs are more susceptible than adult pigs to develop the disease, and management conditions, such as biosecurity and various pathogen factors, are more complex in a growing/finishing herd [12].

We have experienced that most pig farms owners maintaining PRRSV-free conditions tended to hesitate in using PRRSV vaccination in growing pigs because of the susceptible age for PRRSV infection and the lack of data to indicate to the efficacy of the vaccine on growth performance. In reality, it is generally speculated that PRRSV vaccination may be a potential strategy to reduce not only the virus shedding to environment but also the severity of respiratory signs of growing pigs [5, 8, 12]. Therefore, the aim of the present study was to examine serologic responses and growth performance parameters in growing/finishing pigs with or without a commercial PRRSV MLV vaccination under conventional conditions. The present pilot study particularly focused on quantifying the growth performance of pigs originating from a PRRSV-free herd and vaccinated with a commercial MLV vaccine at growing age.

This conventional pig farm was two-site production system comprising a farrow-to-growing site of 450 sows and

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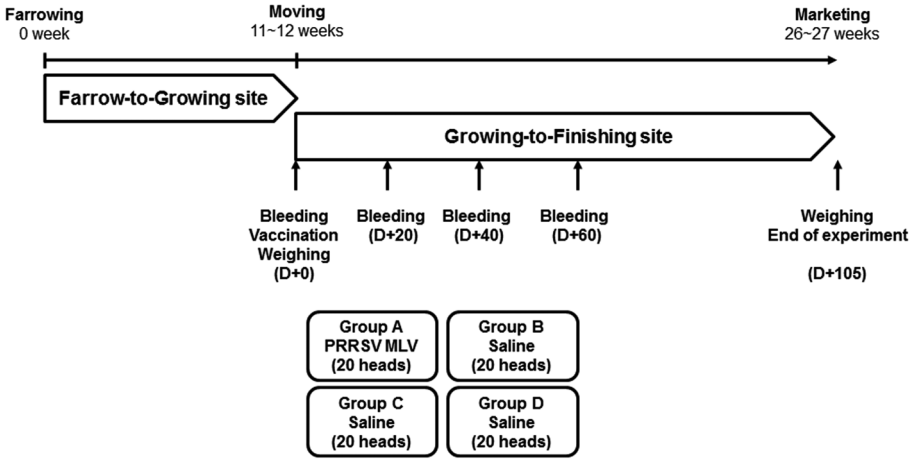

Fig. 1. Diagram showing the pig flow, vaccination, sampling and measuring body weight in this study. Growing pigs moved from the farrowing site were reared in the four barns. The pigs of barn A were vaccinated with a commercial PRRSV MLV, and other pigs of barns B, C or D were given sterile saline. Twenty pigs were randomly selected from each barn and used in the experiment.

a growing-to-finishing site. Previously, the farm owner attempted to eliminate PRRSV in the farrow-to-growing site served by the consulting practice with a swine veterinarian. All pigs on the site were routinely vaccinated with a commercial *Mycoplasma hyopneumoniae* vaccine during the nursery phase, but did not receive a PRRSV vaccine. The virus elimination was established by complete depopulation and repopulation with PRRSV-negative pigs. Isowean and segregated early weaning strategies were also performed for the PRRSV elimination. Finally, the status of all sows and offspring at the site was maintained continuously until the present study.

In contrast, no vaccine was administered to the pigs of the growing-to-finishing site, and a strict all-in/all-out management system with cleaning and disinfecting was followed in all facilities. In general, growing pigs on all barns were infected with various respiratory pathogens since 4 weeks after moving, which frequently resulted in PRDC, and the coinfection with type 2 PRRSV strain was identified in the Virology Laboratory, Korea Research Institute of Bioscience and Biotechnology. The overall mortality recorded on all barns at the site was approximately 5%. Therefore, the veterinarian proposed that PRRSV vaccination may be a worthwhile consideration to reduce disease problems in the herd.

Four barns were designated for the four study groups (A, B, C and D) in the growing-to-finishing site. Subsequently, all pigs (between 11 weeks and 12 weeks of age) of barn "A" were vaccinated with a commercial PRRSV MLV (Ingelvac PRRS MLV; Boehringer Ingelheim Vetmedica Inc., St. Joseph, MO, U.S.A.), and all pigs of the age of barns B, C or D, as control groups, were given sterile saline (Fig. 1). Twenty pigs were randomly selected from each barn, and total 80 pigs were individually identified with an ear tag and weighed simultaneously (Fig. 1). All pigs used in the present study were visually monitored daily by the farm owner for clinical abnormalities. All animals used in this study were treated according to guidelines approved by the Institutional Animal Care and Use Committee of the Chonbuk National University (Approval number: CBNU 2014–0078).

For PRRSV antibody examination, blood samples were drawn from all pigs into sterile blood vacutainer tubes via jugular venipuncture at 0, 20, 40 and 60 days post vaccination. A commercial enzyme-linked immunosorbent assay (ELISA) kit (HerdChek PRRS X3, IDEXX Laboratories Inc., Westbrook, ME, U.S.A.) was used to determine the PRRSV serological response according to the manufacturer's protocol and instructions. The presence or absence of PRRSV antibodies was determined by calculating the sample to positive (S/P) ratio (S/P ratio≥0.4). To calculate the average daily weight gain (ADG), the body weights of the 20 ear-tagged pigs of each group at moving and the pigs at marketing (between 26 weeks and 27 weeks of age) were recorded in the present study.

The mean ADG (kg/day) among the groups (A, B, C and D) was statistically analyzed using one-way ANOVA test, followed by Tukey's honestly significant difference (HSD) test using the SPSS 10.0 software package for pairwise comparison. A P value of less than 0.05 was regarded as statistically significant.

Overall, most pigs suffered clinical respiratory symptoms ranging from mild to severe in all facilities. The pigs of barn A were evaluated for relatively mild disease symptoms than the pigs in the other barns by the swine practitioner. The mean body weights at moving and marketing, feed efficiency and mortality of each barn are summarized in Table 1.No detectable difference was observed in the performance parameters between vaccinated and unvaccinated groups. Seropositivity of the selected pigs is shown in Table 1. All pigs of group A vaccinated the PRRSV MLV were seropositive at 40 day-post-vaccination, but seroconversion to PRRSV was detected in less than half of the pigs from non-vaccinated

Table 1. Growth performance and seroconversion of growing/finishing pigs with or without PRRS-MLV vaccine in each barn

	A	B	C	D
Performance parameter				
Moved pig number	394	402	432	383
Mean weight at moving (kg)	30.7	28.9	30.2	28.8
Mean weight at marketing (kg)	117.1	112.8	113.6	115.3
Feed efficiency (kg)[a)]	2.81	2.95	3.02	2.84
Mortality (%)	3.7	4.1	3.9	4.2
Seroconversion (%)				
0 dpv[b)]	0 (0/20)	0 (0/20)	0 (0/20)	0 (0/20)
20 dpv	70 (14/20)	0 (0/20)	20 (4/20)	0 (0/20)
40 dpv	100 (20/20)	40 (8/20)	45 (9/20)	25 (5/20)
60 dpv	100 (20/20)	100 (20/20)	100 (20/20)	40 (8/20)

a) feed weight to gain body weight of one kilogram. b) day-post-vaccinaion.

groups at the day. ADG analysis of the randomly selected pigs in the barns revealed a significant difference, which is illustrated in Fig. 2. The mean weights of groups A, B, C and D were 0.82 ± 0.017, 0.76 ± 0.016, 0.74 ± 0.019 and 0.81 ± 0.018 kg, respectively. Based on one-way ANOVA test, the mean ADGs among the groups were significantly different. In particular, the mean ADG of the group A was significantly higher than that of the B and C groups as revealed by the Tukey HSD test (P<0.05).

It is challenging to determine the economic benefit of preventive vaccination as a strategy to minimize productivity losses associated with PRRSV infection under commercial conditions [7]. In fact, PRRSV vaccination has been generally accepted as a strategy to enhance the reproductive performance of sow herds and growth performance of weaned pigs or to achieve the elimination of PRRSV within a herd [10]. Linhares *et al.* (2012) first described a novel concept of therapeutic vaccination against PRRSV infection as an additional option to control the spread of the virus in growing pig populations, although the dissemination of the virus throughout the population is likely to take some time [6]. They demonstrated that PRRSV MLV vaccination is a potential strategy to reduce virus shedding among virus-infected pig populations. However, there was no apparent difference in ADG and feed conversion rate between vaccinated and non-vaccinated groups [6].

In the present study, the effectiveness of a commercial PRRSV MLV vaccine was evaluated in a growing/finishing pig population under field conditions. The growing pigs moved from the PRRSV-free farrow-to-grower site were serologically negative before the present study, whereas those pigs were infected with environmentally contaminated virus in the growing-to-finishing site. It is presumed that the hygiene conditions of each barn may vary despite the same production site, and the growth performance of pigs may be related to the viral contamination conditions. As expected, the pigs of group D among the three unvaccinated groups showed a relatively low PRRSV antibody titer, whereas the groups showed a similar level of ADG.

As is well known, feed can be a major contributor to the cost in pig production on commercial farms [14]. Therefore,

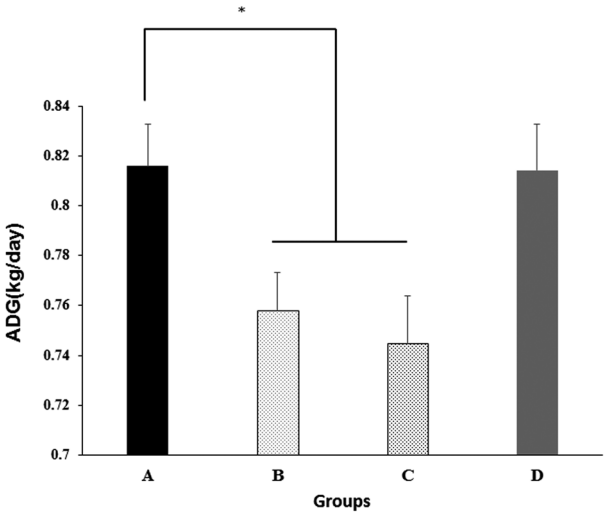

Fig. 2. Mean ADG in growing/finishing pigs vaccinated with MLV vaccine (A) and unvaccinated pigs (B, C and D). The data show means and standard deviations. Asterisks indicate statistically significant differences in ADG between groups (P<0.05).

there is a need to estimate the economic benefit of PRRSV vaccination by the validation of improvement or the maintenance of body weight gain in growing pigs [7]. In this regard, the present pilot study had some limitations in that the parameters of growth performance were collected from a single conventional farm, and the identification of the PRRSV antigen was not conducted in the pigs. Moreover, the presence of other agents associated with PRDC was not determined in this study. Nevertheless, we previously stressed that the present study aimed to demonstrate the effect of the PRRSV-vaccine effect in growing pigs under conventional farm conditions of contamination with various respiratory pathogens. Additionally, the serological examination for PRRSV may be sufficient to track the viral infection in the pig herds as we applied the commercial PRRSV MLV vaccine having the genotype identical to that of the strain spreading in the growing-to-finishing site.

In conclusion, the present study reports the growth performance by the PRRSV MLV vaccine effect in growing/finishing pigs under field conditions. In particular, the growing pigs were obtained from a PRRSV-free population, and the vaccinated pigs and infected pigs without vaccination at 2nd site showed different body weight gain at marketing. We frequently experienced that most farm managers tended to avoid PRRSV vaccination as it was not convenient to estimate and compare the economic advantage of the vaccination to farms. Despite the limitations of the present study, the results suggest that PRRSV vaccination in growing pigs can be a potential strategy to enhance growth performance. Further studies using more conventional herds will be helpful to verify the economic benefit identified in the present study.

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