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Utilization of multivalent vaccine on sows ante partum for the prevention of piglet enteritis

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Abstract

Three swine farms which were suffering from slight economic loss due to suckling piglets' diarrhea, were selected to apply commercialized multivalent vaccine for sow use; SUISENG® (Hipra, Spain). Farms were pre-diagnosed with clinical symptoms and molecular detection of *C. perfringens* Type A and C and *E. coli* pili by PCR. Sows were vaccinated twice 2 ml of the vaccine at 6 and 3 weeks ante partum intramuscularly according to the manufacturer's instruction. All vaccinated sows did not show any adverse reaction or clinical signs; hypersensitivity, fever, granuloma or abscess on the injection site, appetite loss, and so on. Also, no reproductive disorder was appeared in vaccinated sows compared with non-vaccinated control sows. The results suggested that piglets born from vaccinated sows show significantly better performance in regard of the diarrhea index and mean daily weight gain compared with piglets from non-vaccinated sows. Therefore, the commercial vaccine for the prevention of neonatal diarrhea is found to be effective in reducing diarrhea in the first suckling period of piglets after birth.

Key words : Neonatal diarrhea, Multivalent vaccine, Sow vaccination, SUISENG®

INTRODUCTION

Diarrhea is one of the leading causes of morbidity and mortality in neonatal piglets. Neonatal watery diarrhea is often sudden in onset and causes a rapid decline in clinical condition as the pig becomes dehydrated and develops systemic infections, which made it a significant issue for the swine industry (Parra et al, 2008; Wang et al, 2013). The etiology in specific herd-cases may differ but it is well-known that various pathogens are related with piglet diarrhea including viral pathogens such as porcine epidemic diarrhea virus (PEDV), transmissible gastroenteritis virus (TGEV), porcine rotavirus A (PoRVA) and bacterial pathogens such as *Escherichia coli* and *Clostridium perfringens* (Ogawa et al, 2009; Vemulapalli et al, 2009; Baker et al, 2010; Wang et al, 2013; Han et al, 2016). Although infection with any of these pathogens can lead to high morbidity in neonatal piglets, *E. coli*, a common cause of diarrhea in pigs worldwide, can result in neonatal diarrhea (0～4 days after birth), young piglet diarrhea (1 week old to weaning) and post-weaning diarrhea, which common clinical signs observed include watery to pasty stools, lethargy and dehydration. *Cl. perfringens* specifically causes diarrhea of neonatal piglets with type A usually causing watery diarrhea and enterotoxaemia and type C mostly hemorrhagic diarrhea (Uzal, 2004; Hammer et al, 2008). Thus, prevention, early identification and immediate initiation of supportive care and treatment in piglet diarrheal cases are critical. The aim of this study is to utilize a commercialized polyvalent vaccine (SUISENG®) for sow use containing various pathogenic bacterial anti-

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gens associated with diarrhea as one of preventive measures.

MATERIALS AND METHODS

Vaccine

The vaccine (SUISENG; Laboratorios Hipra, S.A., Amer, Spain) is designed against neonatal diarrhea in piglets and sudden death in sows with an adjuvant, Hipramune-G, which contains purified adhesion factors (F4ab, F4ac, F5 and F6) and the heat-liable toxin (LT) of *E. coli* the β toxin of *Cl. perfringens* type C and the α toxin of *Cl. novyi*.

Farms

Three commercial farms were selected (Table 1) in which piglets with watery diarrhea had been observed and pre-diagnosed with *C. perfringens* Type A and C and *E. coli* pili by PCR at Veterinary Diagnostic Laboratory, College of Veterinary Medicine, Kangwon National University. Farms A, B, and C housed herds of 300, 420, and 300 sows, respectively. In Farm A, piglet diarrhea started around 2～3 days after birth at 18% of neonates and 15% of piglets after weaning. *E. coli* K88, K99 and *Cl. perfringens* type A were detected in fecal samples piglets with diarrhea. In Farm B, 30% of piglets had diarrhea and the diagnosed antigens were *E. coli* K88, K99 and 987P. 10% of piglets had diarrhea in Farm C and diagnosed antigens were the same as the Farm B.

Experimental design

Ten pregnant sows per farm were randomly selected and divided into two groups: vaccinated (n=6) and non-vaccinated (n=4). These pregnant sows were healthy, with similar parity and close parturition date. At 6 and 3 weeks before farrowing, the vaccinated sows received twice with 2 mL IM of multivalent inactivated vaccine (SUISENG®) according to the manufacturer's recommendation. Four sows received 2 mL of physiological saline only. Clinical observations were made daily after vaccination to ensure that all sows did not develop reproductive disorders. After parturition, cross-fostering was not allowed for the litters. The newborn piglets in each group were monitored daily for signs of watery diarrhea.

Fecal consistency score

Fecal consistency was scored daily beginning on day 1 according to a four-ladder whole-number scale (Marquardt et al, 1999) as described previously: 0=normal feces; 1=soft feces; 2=mild diarrhea; 3=severe diarrhea.

Growth performance

The live weight of each pig was measured at birth, 1st week, 2nd week, and weaning. The average daily weight gain (ADG; gram/pig/day) during the different production stages was calculated as the difference between the starting and final weight divided by the duration of the stage. Data for dead or removed pigs were included in the calculation.

Statistical analysis

Summary statistics were calculated for all groups to assess the overall quality of the data, including normality. Statistical analysis was conducted for body

Table 1. Three commercial pig farms were selected, which suffered from neonatal diarrhea

Experiment farms	Size of farms	Diarrhea of suckling piglets	Mortality of piglets	Detection of bacteria
Farm A	300 sows	18%	10%	*E. coli* K88, K99 and *C. perfringens* type A
Farm B	420 sows	30%	10%	*E. coli* K88, K99 and 987P
Farm C	600 sows	10%	10%	*E. coli* K88, K99 and 987P

weight, ADG, fecal consistency score, serologic results, and clinical score, using a Chi-square test. A *P*-value <0.05 was considered to be significant.

RESULTS

Safety monitoring

No allergy reactions were not observed within 1～2 hours after vaccination. No adverse reactions (fever, anorexia, swelling, etc.) were observed within 21 days after vaccination. At parturition, the sows farrowed naturally without any reproductive disorder except a few stillbirths.

Antibody titer

There was no statistical significance in antibody titer to *Cl. perfringens* type C (CpC) of sows. However, in piglets vaccinated group showed significantly higher titer than non-vaccinated group. Antibody titers to *E. coli* (F4ab, F4ac, F5, F6 and LT) were high before vaccination in most of sows but antibody titers of vaccinated group were significantly higher than those of non-vaccinated control group at 2 weeks post second injection. In piglets, antibody titers of vaccinated group were significantly increased compared with non-vaccinated group. Most of vaccinated sows had highest titer at parturition day and their piglets presented highest titer at birth, which decreased gradually.

Fecal consistency score and diarrhea index

The fecal consistency score and diarrhea index were presented in Table 2. The piglets from vaccinated sows showed lower scores and the "Vaccinated/Non-vaccinated fecal consistency score ratio" increased over time in all three farms ($P<0.05$; Table 2).

Average daily weight gain

For the inter-group comparison, ADG (gram/pig/day) between birth and weaning was significantly greater in vaccinated groups of A and C farms compared with non-vaccinated groups ($P<0.05$; Table 3).

DISCUSSION

Of all the diseases in the suckling piglets, diarrhea is the most common and probably the most important. In some outbreaks it is responsible for high morbidity and mortality. At birth the intestinal tract is microbiologically sterile and it has little immunity to disease producing organisms, which begin to colonize the tract quickly after birth, among them potentially pathogenic strains of *E. coli* and *Cl. perfringens* (Hammer et al, 2008; Chan et al, 2013). Immunity to protect neonates from diarrhea by those pathogenic bacteria is initially

Table 2. Fecal consistency score and diarrhea index

Group		Scores		
		1 week	2 weeks	Weaning
Farm A	Vaccinated	0.262*	0.229*	0.081*
	Non-vaccinated	0.752	0.758	0.484
	V/N ratio#	287%	331%	598%
Farm B	Vaccinated	0.281*	0.305*	0.033*
	Non-vaccinated	0.914	0.914	0.514
	V/N ratio	325%	300%	1558%
Farm C	Vaccinated	0.305*	0.310*	0.117*
	Non-vaccinated	0.943	0.929	0.496
	V/N ratio	309%	300%	424%

#Vaccinated group score/Non-vaccinated group score ratio.
*$P<0.05$.

Table 3. Average daily weight gain from birth to weaning (gram/pig/day; group mean±standard error)

Farm	Group	ADG
Farm A	Vaccinated	188.07±13.66*
	Non-vaccinated	167.15±7.31
Farm B	Vaccinated	218.97±8.85
	Non-vaccinated	213.37±10.96
Farm C	Vaccinated	211.53±13.16*
	Non-vaccinated	168.77±11.67

*$P < 0.05$.

provided by the high levels of antibodies in colostrum (IgG, IgM, IgA) formed in their mother via vaccination. After the colostral antibodies have been absorbed into the blood stream, the immunity is maintained by the antibody (IgA) which is present in milk (Oh et al, 2012). IgA is absorbed into the mucous lining of the intestines. It is essential that the newborn piglet drinks sufficient colostrum from properly vaccinated sows soon after birth to prevent potentially pathogenic organisms multiplying against the intestinal wall and causing diarrhea. It is also essential that the piglet continues to drink milk regularly after the colostrum has gone so that its intestines continue to be lined by protective antibodies. Of course, environmental stress such as chilling also plays a role because it lowers piglets' resistance (Zanello et al, 2012; Goede et al, 2015).

The economic consequences of neonatal diarrhea can be substantial. In studies conducted in Sweden and Denmark, diarrhoea is estimated to account for 5～24% of the overall pre-weaning mortality (Pedersen, 2010; Westin et al, 2015) and to reduce ADG by 8～14 g per day (Johansen et al, 2004; Kongsted et al, 2014). Based on these effects, the cost of neonatal diarrhea was recently estimated to 134 € per sow and year (Sjölund, 2014). Apart from the economic consequences, neonatal diarrhea has other important implications. The development and spread of antibiotic resistance is one of the greatest threats to both animal and human health (Wise et al, 1998).

In our research the multivalent vaccine for sow use designed against neonatal diarrhea in piglets and sudden death in sows was studied under field condition in which previously neonates' diarrhea was observed. The vaccine was safely applied on pregnant sows and played a role to increase antibody titers in all of the vaccinated sows compared with non-vaccinated sows.

The results suggested that antibody titers of piglets born from vaccinated sows were greatly increased. At parturition, antibody titers of all sows in either vaccinated group or non-vaccinated group were not significantly different, although vaccinated sows presented higher antibodies than non-vaccinated sows. The reason that there was no statistical significance in antibody titer to CpC in sows seemed to be due to in-house infection circulation. However, piglets delivered from vaccinated group showed significantly higher titer than non-vaccinated group due to their mother's immune colostrum. The F5 antibody titers in 2-week-old piglets of non-vaccinated control group were high, which might be caused by early infection of *E. coli* F5. Some of non-vaccinated control group showed seroconversion but this seroconversion appeared to be irregular over time, probably due to in-house infection. In regard of fecal consistency and ADG, the vaccinated group showed better performance than the non-vaccinated group.

Our study eventually suggested that SUISENG®, the multivalent vaccine formulated with Hipramune-G be effective in prevention and improvement diarrhea symptoms with colibacillosis and clostridiosis in preweaning piglets. According to application of SUISENG® in sows, it is expected that overall health condition and productivity of sows and their piglets can be improved in swine industry of Korea.

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