



Influence of Pig Breeds on Growth Performance and Immunity During Pre-weaning Period

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Abstract This study was conducted to find out the influence of pig breeds on growth performance and immunity during the pre-weaning period. The experimental design consisted of a completely randomized design and was performed with a total of 892 piglets acquired from 105 Thai native (TN), Meishan (MS), and Large white x Landrace (LWxLR) sows. After farrowing, the piglets were weighted daily until weaning at 21 days of age and the average daily gain (ADG) was calculated. Serum samples were collected from piglets at 12 and 24 h and IgG concentrations were determined by the ELISA technique. The growth performance of LWxLR piglets measured at birth and at seven days (1.43 ± 0.20 and 2.67 ± 0.20 , respectively) was higher ($p < 0.01$) than TN (0.65 ± 0.15 and 1.12 ± 0.15 , respectively) and MS (1.07 ± 0.02 and 1.97 ± 0.37 , respectively). The growth performance of MS piglets was similar ($p > 0.01$) to LWxLR piglets at fourteen and twenty-one days of ages. The ADG of MS and LWxLR were significantly ($p < 0.01$) higher than TN during all lactation periods. However, the piglets of MS showed the highest ADG at fourteen days. The IgG concentrations in all breeds at 12 h were less than 24 h but the values were not considered significant ($p > 0.01$) among the breeds. The present results indicate that different pig breeds did have an effect on growth performance and ADG. Moreover, this study showed that low birth weight of piglets resulted in low growth performance, but IgG concentrations were not found to be different among the breeds.

Keywords piglet, breed, immunity, body weight

INTRODUCTION

The growth potential of pigs is influenced by many factors (breed, sex, and stage of growth), including housing conditions (floor type, space allowance and group size) and climatic factors (temperature, relative humidity, air speed). Breed is an important factor that can affect the growth potential of pigs (Renaudeau et al., 2006). Indigenous breeds of pigs have lower rates of feed conversion efficiency, growth rates, and growth potential than exotic breeds (Nwakpu, 2013). The breeds of pigs display different characteristics. Certain cross breeds (Landrace, Large white, Duroc, Pietrain) have high levels of growth performance, carcass quality and meat quality (McClann et al., 2008), but cross breed has been known to be least adaptable in hot humid climates (De et al., 2013), while certain local breeds (Thai native, Meishan, Korean native black pigs, Mongcai) possess higher fat content than cross breeds and adapt well to hot and humid climates, can tolerate low quality feed, and are resistant to disease (Rattanarongchart, 1994). For example, Thai native pigs display significant genetic differences with certain cross breeds (Large White, Spotted Large White, and Pietrain) (Chaiwatanasin et al., 2002).

Meishan is the local pig breed of central China (Bazer et al., 1988). The Meishan breed displays low growth performance, low muscle content, and low quality of ham, but their fat percentage was higher than that of the Large White and Pietrain breeds, and Meishan also adapted well with trough feeding (McLaren, 1990; Van Milgen et al., 1998). Breed is not the only factor that can be related to growth potential (Gerbens et al., 1999) and disease resistance of pigs (Lamont, 1998). It has been determined that immunity is also related to growth potential and disease resistance in pigs (Porter and Hill, 1970). Colostrum provides nutrition (Farmer and Quesnel, 2009), energy and maternal antibodies to piglets (Dividich et al., 2005). New-born piglets acquired immunoglobulin from colostrum after parturition on the fifth day after ingesting colostrum and milk for passive immune protection (Xu et al., 2000). Immunoglobulin concentrations in the plasma of piglets depend on the amount of colostrum ingested by the piglet. Immunoglobulin concentrations in the colostrum and the timing of the gut closure (when intact IgG can no longer be absorbed by the gastrointestinal tract of the piglet) are related. However, the capacity of the piglets is revealed when they have absorbed adequate amounts of IgG for disease protection (Rooke and Bland, 2002).

OBJECTIVE

The objective of this study was to find out the influence of pig breeds on growth performance and immunity during the pre-weaning period.

METHODOLOGY

Experimental Flow

This experiment was conducted at a designated demonstrative and training swine farm at the Department of Animal and Aquatic Sciences, Faculty of Agriculture, Chiang Mai University. The experimental design was a completely randomized design involving 3 treatments, and the total piglets in each breed were used as a replication. One hundred and five sows belonging to Thai native (n=35), Meishan (n=28), Large white x Landrace (n=42) breeds and their litters (251 piglets from Thai native, 299 piglets from Meishan, and 342 piglets from Large white x Landrace) were observed from birth to weaning at 21 days of age. The day of birth was defined as day 0 of age. During the suckling phase, piglets were housed in farrowing pens where they were individually penned until weaning. Pens were equipped with nipples, feeders, creep boxes containing a heat lamp and an opening to permit free access to the piglets. From day 10 of lactation, piglets were offered creep feed but intake values could not be measured.

During the first 12 weeks of gestation, sows were fed 2 kg/day, and during the last 4 weeks, 3 kg/day (formulated to contain 12% CP, 0.53 lysine, 3,190 kcal ME/kg). After farrowing, sows were fed the same feed formula, but feed intake was distributed according to litter size. Sows had free access to fresh water.

The farrowing process was induced on day 114 of gestation with 1 ml of prostaglandins (Cloprostenol Sodium). Piglets received 2 ml of oxytocin (2 ml of a 10 IU/ml solution; General Drugs House Co., Ltd) by intramuscular route. Parturitions were watched but observers interfered as little as possible in the farrowing process and manual birth assistance was only performed when the birth interval exceeded 1h immediately after birth, piglets were dried with the use of powder, their umbilical cords were clamped, and they were weighed using a general balance. Piglets were weighed again at 7, 14, and 21 days of age. All the piglets were weaned at 21 days. At three days after birth, all piglets received iron (Ferric oxide dextran solution with phenol) 2 ml/piglet by intramuscular injection.

IgG concentration was determined in the serum. Blood samples were collected from piglets via jugular venipuncture at 12 and 24 h after farrowing. The blood samples were centrifuged for 10 min at

1,500 rpm and serum samples were stored at -20 °C until analysis. IgG concentration was evaluated by Enzyme linked immunosorbent assay (ELISA). A modified method of Devillers et al. (2004) was employed. The plates were coated with 100 µl of rabbit anti-pig IgG (whole molecule) in 1% in 0.05 M sodium bicarbonate solution (pH 9.6) and incubated overnight at 4 °C. After that, the plates were washed 3 times with a washing buffer. Then, TBS containing 1% BSA was added and the specimens were incubated for 1 h at 20 °C. Thereafter, the plates were washed 3 times using a washing buffer. Then, the serum sample was added to the plates and the standard (pig IgG) was placed into duplicate wells and incubated for 2 h at 20 °C. The plates were then washed 3 times with a washing buffer. Rabbit anti-pig labeled peroxidase 10 µl was added to each well and the specimens were incubated for 1 h at 20 °C. After that, the plates were washed again 3 times with a washing buffer. Then, the substrate OPD was added and the colored reaction was stopped by 100 µl 4 M H₂SO₄ and the absorbance was read at 492 nm. Ultimately, the standard curve was calculated for the sample.

Data Analysis

In terms of the statistical method, data were analyzed by using the procedure of SPSS Windows. All statistical tests were performed with SPSS Statistics 17.0 (SPSS Inc., Chicago, IL). For the analysis of growth performance, piglets were weighed daily from birth to weaning and the average daily gain (ADG) and IgG were calculated. The observed mean in multiple comparisons was based on the Duncan Post Hoc test. Using the SPSS for Windows, Pearson's correlation coefficients were estimated for the treatments.

RESULTS AND DISCUSSION

The influence of pig breed on growth performance and average daily gain during the pre-weaning period is presented in Table 1. The body weights of all treatments increased over time. However, the body weights of TN piglets were the lowest. The average daily gain (ADG) of TN piglets was lower than those of the MS and LWxLR breeds at 14 and 21 days. The LWxLR breed was significantly higher at birth and at seven days (1.43 ± 0.20 and 2.66 ± 0.20 , respectively) compared to piglets of TN (0.65 ± 0.15 and 1.12 ± 0.15 , respectively) and MS (1.07 ± 0.02 and 1.97 ± 0.37 , respectively) breeds ($p < 0.01$). However, in this regard, MS piglets were not found to be significantly different ($p < 0.01$) from the LWxLR breed at fourteen and twenty-one days of age. For the ADG of the MS and LWxLR breeds, it was found to be significantly higher than the that of the TN breed during the pre-weaning period ($p < 0.01$), but ADG of the MS and LWxLR breeds were not found to be significantly different during all lactation periods and the piglets of the MS breed (0.20 ± 0.05) had the highest ADG at fourteen days.

The results of our study indicated that there is a significant effect of breed on performance traits. The body weights of piglets from each breed for all treatments during the pre-weaning period were both negatively and significantly correlated with birth weight in accordance with previous results obtained in our study (Skorjanc et al., 2007). In our study, birth weights of TN pigs were lower than those of the cross-bred piglets, and TN pigs were also lower in growth potential and ADG than the cross-bred piglets, which were similar to the findings of the report of Skok et al. (2008) who studied the growth performance of piglets during the lactation period. Their results showed that heavy piglets at birth were still heavier at the end of lactation in comparison to light piglets. Vaclavkova et al. (2012) reported that low birth weight piglets grew at lower rates than pigs with higher birth weights and that low birth weight piglets gained less weight during all periods of production, and they also had less longissimus muscle (Fix et al., 2010). The results reported herein are also in agreement with the study conducted by Kaensombath and Lindberg (2012) that studied the growth performance of exotic and native breeds and found that cross-bred piglets displayed higher growth performance than native breeds.

The native breed piglets had lower performance and production inputs, but displayed excellent adaptation traits when compared with exotic breeds (Keonouchanh et al., 2011). Nwakpu (2013) studied the characteristics of inbred and cross-bred native piglets with regard to pre-weaning and weaning growth performance levels in pigs. They found that the effects of growth potential among native pigs were more affected inbred than exotic breeds, and that pre-weaning and weaning performance values of the cross-bred piglets were better than those of the native pig breeds because of the dominant genes that were acquired from the exotic parent. The significant differences observed among the genetic delivery of four pig breeds in Thailand suggested that Thai native pigs displayed the highest genetic diversity between Large White (LW), Spotted Large White (SLW), and Pietrain breeds (there was a great genetic differentiation observed between Thai native breeds and the other three breeds) (Chaiwatanasin et al., 2002). Leenhouders et al. (2002) reported that high genetic merit of piglets could improve the ability to cope with hazards during birth and the first days of life. Renaudeau et al. (2006) showed that the performance and the feeding records of pigs raised in tropical climates were affected significantly by their breeds. The native breeds better tolerated hot conditions than the cross breeds. The best heat tolerance was observed in indigenous breeds and this was associated with a greater ability to lose heat.

Table 1 Body weight and Average daily gain (ADG) of each breed during lactation period

Variable	Age, day	TN	MS	LWxLR	SEM	P-value
BW, kg	Birth weight	0.65±0.15c(d)	1.07±0.02b(d)	1.43±0.20a(d)	0.065	0.000
	7	1.12±0.15c(c)	1.97±0.37b(c)	2.66±0.20a(c)	0.068	0.000
	14	1.61±0.15b(b)	3.74±0.48a(b)	3.84±0.18a(b)	0.106	0.000
	21	2.20±0.15b(a)	4.55±1.18a(a)	5.05±0.42a(a)	0.134	0.000
ADG, kg	7	0.07±0.00b	0.13±0.05ab	0.18±0.24a	0.016	0.05
	14	0.07±0.01b	0.20±0.05a	0.17±0.01a	0.018	0.00
	21	0.07±0.01b	0.17±0.06a	0.17±0.21a	0.016	0.05

a,b,c Means with different superscripts within a row differ, $p < 0.01$

(a),(b),(c), (d) Means with different superscripts within a column differ, $p < 0.01$

Breeds: TN=Thai Native, MS=Meishan, LWxLR=Large whitexLandrace

Table 2 IgG concentrations of piglet serum at different times in each breed

Stage of lactation(h)	Immunoglobulin G, mg/ml			SEM	P-value
	TN	MS	LWxLR		
12	16.98±2.98	17.90±2.43	15.28±3.33	0.759	0.388
24	21.32±3.29	20.90±2.29	20.06±3.73	0.768	0.817

Breeds: TN=Thai native, MS=Meishan, LWxLR=Large whitexLandrace

The concentrations of IgG in each breed at 12 h were less than 24 h of all breeds (Table 2). The IgG concentration in the serum of piglets increased over time. However, IgG concentration was not significantly different for different breeds ($p > 0.01$). The immunoglobulin is secreted from the mammary tissue in the mammary gland (Foisnet et al., 2010). The transport of maternal immunoglobulin to the neonate occurs by two routes: the blood stream and colostrum, and immunoglobulin transfer in quantity in the blood stream or via the colostrum is mainly of the IgG class and has lower concentrations of IgA and IgM (Bourne and Curtis, 1973). Markowska-Daniel and Pomorska-Mol (2010) reported the average concentrations of IgA, IgM, and IgG in sow serum 10 days before parturition were 1.58, 6.12 and 39.56 mg/ml, respectively. After farrowing 7 days, the average of IgG concentrations level was lower (34.94 mg/ml), but concentrations of IgA and IgM level increased to 2.25 and 7.25 mg/ml. For the colostrum of sows at farrowing, the IgG concentration was 118.5 mg/ml, the IgA concentration was 23.8 mg/ml and decreased to 7.85 mg/ml at 6 h and to 4.59 mg/ml at 24 h, and concentration of IgM was 12.1 mg/ml and decreased to 4.23 mg/ml at 24 h postpartum. Cabrera et al. (2012) studied the influence of colostrum and serum immunoglobulin G on

neonatal piglet survival. It was confirmed that the concentration of IgG in the serum was 1,000 mg/dl and displayed a 67% piglet survival rate at weaning. Serum IgG concentrations were recorded at between 2,250 to 2,500 mg/dl and displayed a 91% survival rate at weaning. Farmer et al. (2007) studied the influence of genotype on colostrum and the milk composition of primiparous sows (Belgian Landrace, Duroc, Landrace and Yorkshire). They found that colostrum and day-2 milk from Duroc sows contained more protein and less amounts of lactose than sows of other genotypes. The first-born piglet had low energy stores and was devoid of serum immunoglobulin (Dividich et al., 2005). Colostrum samples contained nutrition and immunoglobulin. Both of them are comprised of important energy and maternal antibodies that are provided for the survival and development of neo-natal piglets (Devillers et al., 2011). Csapo et al. (1995) researched the composition of colostrum in porcines. The results showed that the first colostrum samples contained 16.65% of total protein. The high protein content in colostrum was largely produced by the immunoglobulin. During the first 6 h after farrowing, IgG accounted for nearly all the protein in the colostrum (Klobasa et al., 1987). Kielland et al. (2015) investigated the association between IgG in sow colostrum and piglet plasma. They found that the colostrum IgG and piglet IgG had a strong association and that when the IgG level in the colostrum was increased, the levels of IgG in the piglets would improve and this would potentially increase the survival rates of the piglets. Quesnel et al. (2012) and Devillers et al. (2007) reported that the consumption of 200 g of colostrum per piglet during the first day after birth significantly reduced the risk of mortality before weaning, while the consumption of 250 g of colostrum was an indicator of good health and pre-weaning and post-weaning growth among piglets.

CONCLUSION

In conclusion, the presented data has demonstrated the breeds of pigs influenced body weight and ADG during pre-weaning period. The MS and LWxLR showed better growth performance than TN. However, the pig breeds did not affect the IgG concentration in serum of piglets at 12 and 24 h.

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