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Association between Backfat Depth and Litter Size at Birth in Primiparous Sows

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ABSTRACT

This study was undertaken to investigate the association between backfat thickness (BF) at insemination and litter size at the birth of first parity sows. In total, 201 Landrace × Yorkshire crossbred gilts raised in a conventional open housing system from the eastern region of Thailand were included. The measurement of BF was performed using A-mode ultrasonography at the first mating day, the 70th day of gestation period, and 1 wk prior to farrowing. The gilts were categorized on the criterion of BF at the mating day into three groups: high (17–20 mm), moderate (14–16.5 mm), and low (11.0–13.5 mm). The results revealed that the gilts in the high group possessed the biggest litter size (13.1 ± 0.5 piglets), compared to the moderate and the low groups which had 12.0 ± 0.4 and 12.0 ± 0.6 piglets per litter, respectively.

Keywords: backfat thickness, gilts, litter size at birth, A-mode ultrasonography

INTRODUCTION

It is well documented that the replacement gilt is the major production unit of the swine production industry (Tummaruk *et al.,* 2010). Under field conditions, the substitution of the removed sows by the replacement gilts accounts for approximately 40–55% annually (Lucia *et al*., 2000; Stalder *et al*., 2005; Engblom *et al*., 2007). One of the significant problems in the swine breeding industry is to remove pigs for various reasons, including planned and unplanned removals. The most common reason for culling among pig breeding herds is reproductive failures, such as an inability to conceive, repeated breeding, and anestrus (Lucia *et al*., 2000; Tummaruk *et al*., 2006). Earlier studies have demonstrated that 19% of sow culling occurs at the zeroth parity and 15% at the first parity (Lucia *et al*., 2000). Furthermore, among the culled gilts, 65% was culled on account of reproductive problems (Lucia *et al*., 2000). Moreover, many reproductive problems and a high mortality rate are observed in the sows in the first and the second parities (Roongsitthichai *et al*., 2010). These studies indicated that the management of the gilts under the field conditions is an important research area to be investigated. An increase in the culling rate and replacement rate in the modern pig industry has led to a requirement to increase the size of the gilt pool and optimize the administration of replacement stock. Information regarding the biological

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background of the gilts, such as the optimal backfat thickness (BF) is necessary for proper pig breeding management. In various commercial swine herds in North America, feeding regimens for the gilts and sows rely mainly on the body condition score (BCS; Young *et al.*, 1991). Recent studies in Canada and the United States of America have demonstrated that the sows with a BCS of 3 range in BF from 9 to 28 mm. BCS and BF appear to be poorly correlated ($R^2 = 0.19$; Young *et al.*, 1991). This illustrates the need to determine a more objective method of measuring body condition, such as ultrasonography, to appropriately adjust the feeding regimen to attain the highest yields (Young *et al.*, 1991). A-mode ultrasonography is routinely used to measure the BF in live pigs (Magowan and McCann, 2006) and is available with either an optical or ultrasonic probe. A recent study proved no difference in accuracy between the two kinds of probes (Magowan and McCann, 2006).

The preceding studies pointed out the close relationship between reproductive performance and BF in pigs; for instance, the gilts with high BF are younger at first insemination and have a higher farrowing rate, a larger litter size and a shorter wean-to-first-service interval when they are in the second parity, compared with those first inseminated with low BF (Tummaruk *et al.*, 2001). Meager comprehensive studies were found on the relationship between BF at first mating and during gestation on the litter size at birth in the first parity sows. The objective of the present study was to investigate the association between BF at insemination and the litter size of primiparous sows.

MATERIALS AND METHODS

Animals

The study was carried out on a commercial swine herd in Thailand between November 2008 and June 2009. In total, 201 Landrace × Yorkshire (LY) crossbred gilts were included. The gilts entered the gilt pool at about age 20–24 wk with a body weight (BW) of 80–100 kg. In the gilt pool, water was provided ad libitum via water nipples. The feed was supplied twice a day (about 3 kg/day/head). The feed was a corn-soybean-fish base containing 16–18% crude protein, 3,000-3,400 kcal/kg metabolizable energy, and 0.85–1% lysine. The pigs in the present study were reared in the eastern part of Thailand in a breeding herd with approximately 900 sows on production. The herd produced replacement gilts internally by using their own grandparent stocks. The gilts were accommodated in a conventional open housing system facilitated with water sprinklers and electrical fans. Generally, the gilts were vaccinated against foot-and-mouth disease, swine fever, Aujeszky's disease, porcine Parvovirus, porcine reproductive and respiratory syndrome virus, porcine Circovirus type 2, swine influenza virus, atrophic rhinitis disease, Mycoplasma disease, and Actinobacillosis pleuropneumoniae at ages between 20 and 32 wk. Swine erysipelas and leptospirosis vaccines were combined with the porcine Parvovirus vaccine. The gilts were kept in pens with a group size of between 6 and 10 gilts/pen at a density of 1.5–2.0 m^2/gilt. Boar contact and estrous detection were performed when the gilts were aged between 24 and 35 wk. A mature boar was presented to the gilts once or twice a day, with fence line contact. The estrous detection was performed by an observation of vulvar characteristics and a back pressure test with the existence of a boar. The gilts expressing a standing reflex in front of the boar were considered estrus. The detection of estrus was performed by experienced stock persons and the days of standing estrus were recorded. In general, the gilts were inseminated when they were aged about 32 wk onwards with at least 130 kg of body weight (BW) at the second or later observed estrus. The mating technique for all gilts was conventional artificial insemination (AI).

Body weight measurement

BW and BF of the replacement gilts entering the herds were measured individually. The BW was measured at age 150 d by a conventional balance. In addition, average daily gain (ADG; g/day) from birth to age 150 d was calculated by ADG = (BW – 1.5/150) × 1,000.

Backfat thickness measurement

The BF was measured by A-mode ultrasonography (Renco lean meter®, Minneapolis, MN, USA) at the P2 position (about 6–8 cm from the dorsal midline) on both sides, above the last rib of the gilts. An average value from the two sides was calculated and recorded as the BF of the gilt (Tummaruk *et al*., 2009). The BF was measured three times: at insemination (BF1), at 70 d of gestation (BF2), and at 1 w before expected farrowing (BF3). The BF gain (BFG) from insemination to 70 d of gestation (BFG1), and from 70 d of gestation to farrowing (BFG2) was also calculated.

Statistical analyses

The data in the present study were statistically analyzed using Statistical Analysis Software (SAS version 9.0, Cary, NC. USA). Measurements of BW, BF1, BF2, BF3, BFG1, BFG2, ADG, the number of piglets born alive per litter (BA), and the total number of piglets born per litter (TB) were analyzed using basic descriptive statistics in terms of quantitative data and frequency analysis. The statistical model included BF1 class (high, moderate, low) as the independent variable, while TB and BA were the dependent variables. The correlations among BW, BF1, BF2, BF3, BFG1, and BFG2 were analyzed using Pearson's correlation coefficient. The association between BF and TB was analyzed using a general linear model (GLM) procedure. Least-squares means were obtained from each class of factors and were compared by a least significant difference test. Values with $P < 0.05$ were considered statistically significant.

RESULTS

Measurements (mean ± SD) determined that BF1, BF2, and BF3 were 15.4 ± 2.0, 17.9 ± 2.5, and 20.3 ± 2.9 mm, respectively. BFG1, BFG2, and BFG were 2.5 ± 2.7, 2.4 ± 2.2 and 5.0 ± 3.1 mm, respectively. Average TB was 12.4 ± 3.6. Reproductive data including BW at age 150 d, ADG, and BF are presented in Table 1. The gilts in the high group produced 13.1 ± 0.5 TB, while those in the moderate and the low groups had 12.0 ± 0.4 and 12.0 ± 0.6 TB, respectively (Figure 1). These statistics demonstrated that the gilts having high BF at the first insemination tended to have the biggest litter size at birth ($P = 0.1$); meanwhile those in the moderate and the low BF categories showed no significant difference in the litter size at birth ($P = 1.0$). Furthermore, the results showed that the association between BF1 and TB tended

Table 1 Descriptive statistics.

Parameter	Number	Mean±SD	Range
Body weight at age 150 d (kg)	201	76.6 ± 5.6	63 – 89
Average daily gain (gram/day)	201	511 ± 37	420 – 593
BF at first insemination (mm)	201	15.4 ± 2.0	11 – 20
BF at 70 d of gestation (mm)	180	17.9 ± 2.5	11 – 26
BF at farrowing (mm)	154	20.3 ± 2.9	9 – 26
Total number of piglets born per litter (TB)	149	12.4 ± 3.6	3 – 28
Number of piglets born alive per litter (BA)	149	10.7 ± 3.6	0 – 18
Farrowing rate (%)	201	74.1	0 – 100

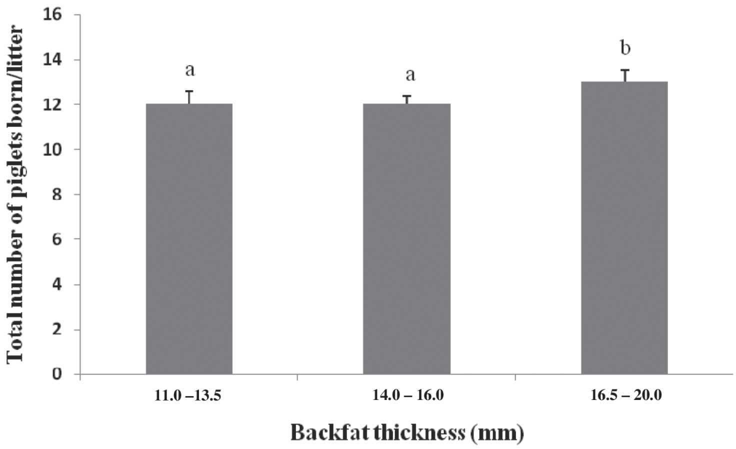

Figure 1 Total number of piglets born per litter (least-squares mean + SEM) by backfat thickness at first insemination in gilts. Different letters on each column indicate a significant difference ($P < 0.05$).

to be positively correlated ($P = 0.1$, r = 0.1). Likewise, TB and BFG tended to be negatively correlated ($P = 0.1$, r = -0.1).

DISCUSSION

In this study, the BF measurement in the replacement LY crossbred gilts demonstrated that the gilts with high BF at insemination day tended to farrow the largest TB compared with other groups. This agreed with the findings of Tummaruk *et al*. (2009) that BF might influence porcine reproductive performance. Moreover, Tarrés *et al*. (2006) demonstrated that if the BF at the end of the growth test (96 kg BW) of the gilts decreased, culling due to low productivity and sow mortality increased. The gilts with BF below 16 mm trended to be removed from the herd owing to low productivity since the litter size at weaning was less than 7.5 piglets (Tarrés *et al*., 2006).

In the present study, the gilts with the lowest BF delivered the lowest number of TB and vice versa. When the rearers observed which gilts were too thin in the gestating pens, they would overfeed them until their body condition scores reached the satisfactory point regardless of the relationship between overfeeding and embryonic loss. Overfeeding during this period would increase the BF accumulation of the gilts. Aherne and Kirkwood (1985) indicated that feeding quantity in the gestation period affected the progesterone (P_4) level and embryo survival. If the pigs were fed large amounts, the blood P_4 level would be 11.8 ng/L and embryo survival would be 71.9%. On the other hand, if a low amount of feed were provided, the blood P_4 level would be 71.9 ng/L and the survival of embryos would be 82.8%. This vividly pointed out that the feeding amount during gestation affected the litter size at birth. The present study has demonstrated that the BF of the LY crossbred gilts tended to be associated with TB.

The BF measurement in this study showed the tendency that BF was one of the factors which dominated litter size at birth in the primiparous sows. Traditionally, BCS is the main factor that pig rearers used in grading the body composition of the pigs (Zaleski and Hacker, 1993; Lucia *et al*., 2002; Borges *et al*., 2005). However, grading the body composition of the pigs using BCS might be far more difficult in swine breeding herds containing more than one breed, due to the inherent variation among breeds that would be noticeable (Whittemore and Schofield, 2000). As a result, BF measurement has become a more objective and precise way of evaluating the body condition in pigs (Charette *et al*., 1996).

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