Abstract

This study was carried out to investigate sperm production in tropical area of boar stud which has been free from porcine reproductive and respiratory syndrome (PRRS) more than ten years and kept in evaporative cooling system, in relation to season and breed influence. Semen production data from 19,966 ejaculates of 517 boars (164 Duroc, 31 Pietrain, 268 Landrace x Yorkshire: LY, 54 Pietrain x Duroc: PD) were collected. Semen parameters; volume (ml), sperm concentration (x10⁶ sperm/ml) and total number of sperm per ejaculate (x10⁹ sperm/ejaculate) were evaluated. The semen production was shown by month and group in relation to season as summer (Mar-Jun), rainy season (Jul-Oct) and winter (Nov-Feb). On average, the semen volume, concentration, and total sperm per ejaculate were 249.7±97.5 ml, 335.7±95.9x10⁶ sperm/ml and 78.9±28.4x10⁹ sperm/ejaculate, respectively. For the effect of season, the total number of sperm per ejaculate in winter was higher than a period in rainy season (Aug-Oct) (p<0.05) while the concentration in early winter (Nov and Dec) was lower than summer and a month in rainy (Jul) (p<0.05). Effect of breed, the total sperm production of LY crossbred boar (88.2±27.2 x 10⁹ sperm/ejaculate) was higher than purebred Duroc boar (60.2±21.9 x 10⁹ sperm/ejaculate, p= 0.01) and purebred Pietrain boar (76.5±21.8x10⁹ sperm/ejaculate, p= 0.03). The seasonal variation effect was most pronounced in purebred Duroc and Pietrain boars rather than LY and PD crossbred boars. The fertility data using Duroc semen (total number of piglets born and born alive) tended to increase during Mar-Jun and Oct-Dec. The lowest total number of piglets born and born alive were shown in Oct (p< 0.05). It can be concluded that season and breed influencing the sperm production was found in boars kept in EVAP with free PRRS in Thailand.

Keywords: boar, breed, free PRRS, season, semen

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Introduction

Sperm production of boars is affected by several factors such as breed, season, nutrition and housing (Ciereszko et al., 2000; Kunavongkrit et al., 2005; Huang et al., 2010). It was found that the semen production of purebred and crossbred boar including breed lines was different (Sonderman and Luebbe, 2005). Moreover, the semen must be produced from disease-free boar to prevent disease transmission via semen. It has been known that porcine reproductive and respiratory syndrome virus (PRRSV) infection is a very important disease of swine due to its transmission from infected boar to several sows which subsequently affects reproductive performances (Guérin and Pozzi, 2005). The establishment of isolated free PRRS boar station is required for semen distribution to sow herds, which has been successfully done in Thailand. The objectives of the present study were to investigate the sperm production of boar stud which has been free from PRRS in Thailand in relation to breed, seasonal influences and fertility data in a few sow herds.

Materials and Methods

Data of semen production: This study was based on semen production collected from a central isolated boar station in the eastern part of Thailand during the period of January 2006 until December 2009. This station provided semen for AI to three breeder farms (n= 10,000 sows) all year round. A total of 19,966 ejaculates were collected from 517 boars with two purebreds (Duroc, n= 164; Pietrain, n= 31) and two crossbred boars (Landrace x Yorkshire: LY, n= 268; Pietrain x Duroc: PD, n= 54). All boars were trained and identified as proven sires from their fertility data of artificial insemination in PRRS free herds. The seronegative of PRRS was tested with the LAB
(ISO/IEC17025:2005) and had been operated for at least 10 years before the start of the study.

**Semen collection and evaluation:** The ejaculates were collected routinely using the gloved-hand method and evaluated macroscopically and microscopically as subjective motility assessment. The gel free semen parameters including volume (ml) measured by weight, sperm concentration (x 10⁶ sperm/ml) measured by Spermacue® (Minitube, Germany) and total number of sperm per ejaculates (x 10⁹ sperm/ejaculate) calculated by multiplying ejaculating volume and sperm concentration were evaluated. To relate to seasonal effect, the data of daily temperature and humidity were recorded during the studying period.

**General herd management and serology monitoring:** Each boar was kept in individual pens (9 m²/boar) and was fed on 2.2-3.0 kg/day of commercial feed containing 14-18% crude protein. The boars had access to water ad libitum via nipple. The young replacement boars produced from a GGP farm classified as free PRRS status were penned in the quarantine area at least 2 weeks before being trained. The clinical disease and serial blood monitoring were observed during quarantine period. After absolutely free PRRS evidence, all replaced boars were trained and the semen was collected at least twice for evaluation for volume, concentration and motility. To maintain PRRS negative status, all boars were routinely tested for seronegative (S/P ratio < 0.2) by ELISA (HerdChek-PRRS®; IDEXX, Laboratories Inc., Westbrook, MA, USA) and PCR from Animal Health and Technical Service Office.

**Season, temperature and humidity:** Sperm production was calculated in relation to season as summer (March to June), rainy (Jul-Oct) and winter (Nov-Feb). Temperature and humidity were recorded once a day. The Max-Min thermometer which was hung at the center of the housing about 170 cm above the floor was used to record the temperature inside EVAP. Temperature was record every day about 7-8 am, after each recording the device was set to measure a new figure for the next day. The percentage of humidity in EVAP was recorded as the average humidity by using a digital device (TEMP1000®; Italy) which had 2 hygro-sensors located about 20 meters far from each other along the front and back of the housing. The outside temperature and humidity were recorded from The Eastern Part of Thai Meterological Department, Thailand. The two temperature variables were defined as the number of hot days per month (maximum temperature > 25°C) (Auvigne et al., 2010). Season, temperature and humidity: Temperature (°C) and humidity (%RH) were defined as the number of hot days per month (maximum temperature > 25°C) (Auvigne et al., 2010).

**Results**

On the average, semen production resulted as descriptive data in each breed is presented in Table 1. Across the breeds, the average semen volume, concentration, and total sperm per ejaculate were 249.7±97.5 ml, 335.7±95.9 x10⁶ sperm/ml and 78.9±28.4 x 10⁹ sperm/ejaculate, respectively. Duroc boar presented the lowest mean value of volume, 170.0±67.8 ml, but possessed the highest concentration. For the overall sperm output (78.9±28.4 sperm/ejaculate), LY had the highest mean value of total sperm per ejaculate (88.2±27.2 x 10⁹ sperm/ejaculate).

Temperature (°C) and humidity (%RH) between outside and inside EVAP system are shown in Fig 1a. EVAP system enables the outside temperature to be lowered about 4-6°C while the humidity was increased due to its spraying and

**Table 1 Means, standard deviation (SD) and range of sperm production in Duroc (D), Pietrain (P), Landrace x Yorkshire (LY) and Pietrain x Duroc (PD) boars kept in EVAP**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Breed</th>
<th>N</th>
<th>Mean±SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (ml)</td>
<td>D</td>
<td>5,763</td>
<td>170.0±67.8</td>
<td>50-497</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>749</td>
<td>249.5±72.2</td>
<td>65-486</td>
</tr>
<tr>
<td></td>
<td>LY</td>
<td>11,729</td>
<td>293.8±86.0</td>
<td>50-500</td>
</tr>
<tr>
<td></td>
<td>PD</td>
<td>1,725</td>
<td>250.7±67.1</td>
<td>50-500</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>19,966</td>
<td>249.7±97.5</td>
<td>50-500</td>
</tr>
<tr>
<td>Concentration</td>
<td>D</td>
<td>5,253</td>
<td>381.6±88.9</td>
<td>75-600</td>
</tr>
<tr>
<td>(x 10⁶ sperm/ml)</td>
<td>P</td>
<td>659</td>
<td>318.3±91.2</td>
<td>97-600</td>
</tr>
<tr>
<td></td>
<td>LY</td>
<td>11,232</td>
<td>310.0±89.6</td>
<td>80-600</td>
</tr>
<tr>
<td></td>
<td>PD</td>
<td>1,283</td>
<td>381.1±93.3</td>
<td>105-600</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>18,427</td>
<td>335.7±95.9</td>
<td>75-600</td>
</tr>
<tr>
<td>Total sperm</td>
<td>D</td>
<td>5,229</td>
<td>60.2±21.9</td>
<td>12-255</td>
</tr>
<tr>
<td>per ejaculate</td>
<td>P</td>
<td>654</td>
<td>76.5±21.8</td>
<td>19-230</td>
</tr>
<tr>
<td>(x 10⁹ sperm)</td>
<td>LY</td>
<td>11,058</td>
<td>88.2±27.2</td>
<td>17-284</td>
</tr>
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<td></td>
<td>PD</td>
<td>1,279</td>
<td>76.4±26.5</td>
<td>15-203</td>
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<td></td>
<td>All</td>
<td>18,220</td>
<td>78.9±28.4</td>
<td>12-284</td>
</tr>
</tbody>
</table>

**Statistical analysis:** The sperm production data were analyzed using general linear mixed model procedure (MIXED) of SAS version 9.0 (SAS®, NC, USA). The models included boar breeds, year and month in which the semen was collected as fixed effect and included boar identity tested within breed as random effect. Least-squared means were obtained and compared among breeds using Tukey-Kramer test. The total number of piglets born were analyzed using general linear model procedure (GLM) to compare among the month of farrowing data from each farm during 2006-2009. p < 0.05 was regarded as a significant difference.
cooling system. The number of days with a maximum temperature of >25°C were classified as hot days; and the days with a maximum temperature of ≤ 25°C as optimum days (Fig 1b). It was revealed that the hot days were more than twenty days a month in Mar-Jun (summer) and Jul-Oct (rainy) and all the days in April and September were hot days.

Monthly sperm production is presented in Fig 2 ((a) volume, (b) concentration and (c) total number of sperm) by months with * as different superscripts in each legend indicating significant difference (p<0.05) (Summer, Mar-Jun; Rainy, Jul-Oct; and Winter, Nov-Feb).

Accordingly, the total number per ejaculate during Nov to Dec had no difference (p> 0.05) but during Aug to Oct had a significant difference (p< 0.05).

The sperm production in each breed is presented in Fig 3 ((a) volume, (b) concentration and (c) total number of sperm) in Duroc (D), Pietrain (P), Landrace x Yorkshire (LY) and Pietrain x Duroc (PD) boars by months with * as different superscripts in each legend indicating significant difference (p<0.05). The number of hot days (maximum temperature >25°C) with the month of inside temperature of the boar stud equipped with evaporative cooling system (Summer, Mar-Jun; Rainy, Jul-Oct; and Winter, Nov-Feb).

The Least-squared means and standard error of total piglets born by months with * as different superscripts in each line indicating significant difference (p<0.05) (Summer, Mar-Jun; Rainy, Jul-Oct; and Winter, Nov-Feb).
The fertility data, 2006-2009, was recorded from sow herds by using Duroc semen, as shown in Fig 4. The total number of both piglets born and born alive tended to increase during summer (Mar-Jun) and Oct-Dec. Meanwhile, in June to August, the total number of piglets born and born alive tended to decrease. The lowest total born and born alive piglets was shown in October ($p<0.05$).

**Discussion**

This study demonstrates the semen production in a commercial isolated boar station that serves for artificial insemination in grand-parents and parents stock in Thailand. The season, temperature and humidity affected some periods of semen production of both purebred (Duroc, Pietrain) and crossbred (LY, PD) boars that were presented as PRRS-free herd and also kept in EVAP. This study conformed to Sonderman and Luebbe (2008) that the temperature and humidity could affect the semen production by showing the lowest trash rate or high number of total sperm of semen production during winter. Moreover, the negative effect of high temperature on semen quality was also observed during hot summer (Kunavongkrit et al., 2005). According to Sonderman and Luebbe (2008), exceeding 29°C (85°F) with 85% humidity affect spermatogenesis. In general, the first indication of abnormal sperm production is observed after the onset of high temperature and when motile sperm do not return to a normal ration until 5 weeks due to spermatogenesis (Yang et al. 2010).

Selection of boars, used in tropical climates, based on sperm production is therefore important because Thailand is located in the tropical area. Nowadays, to control the fluctuation of inside temperature EVAP system is adapted for housing; however, the number of hot days can still be recorded over and over. Male animals that have been suffering several hot days critical effect on total number of sperm per ejaculate throughout the year, while Pietrain possessed the lowest concentration and total sperm production ($p<0.05$). Duroc produced the lowest volume but produced the highest concentration all year round ($p<0.05$). The total sperm production of LY crossbred boar was higher than Duroc ($p=0.01$) and Pietrain ($p=0.03$).

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**Conclusion**: Breed can affect semen production in PRRS free boars living in EVAP while season can affect semen in some period especially during high humidity as rainy. The semen production of crossbred LY boars in Thailand was superior to Duroc and Pietrain boars. To produce good semen production and high fertility, PRRS free status is necessary to perform the good health status.
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References


