

SEASONAL VARIATION ON SEMEN PRODUCTION IN DIFFERENT BOAR BREED IN THAILAND

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ABSTRACT

Fertility of boar depends on semen quality. Factors, such as breed, age, season, temperature and photoperiod are related to the boar semen quality. Monitoring of semen parameters is crucial for artificial insemination (AI) center. The objective of the present study was to investigate semen production in different boar genotypes in an evaporative cooling system AI center in Thailand. Data of boar semen production from October 2009 to August 2015 were collected from an AI center in the western region of Thailand. A total of 1,870 ejaculates were collected from 44 boars. The breed of boars included Duroc (n=11), Yorkshire (n=15), Landrace (n=15) and crossbred boars (Hybrid Pak-Chong5, n=3). All the boars had been identified as proven sire. Semen volume, sperm concentration and subjective motility were evaluated. The concentration of spermatozoa was measured by using a photometer micro cuvettes (Spermacue®). The total number of sperm per ejaculate were calculated from the semen volume multiply by sperm concentration. Seasons were classified as cool (15th Oct - 14th Feb), hot (15th Feb - 14th Jun) and rainy (15th Jun - 14th Oct). The data were analyzed by using general linear mixed model procedure. The statistical models included boar genotypes, year and season of collection as fixed effect. Boar identity was included in the model as a random effect. On average, the semen volume, sperm concentration, total number of sperm per ejaculate and extended semen dose per ejaculate were 264.6 ± 93.5 mL, $276.2 \pm 122.6 \times 10^6$ sperm/mL, $68.1 \pm 28.4 \times 10^9$ sperm/ejaculate and 15.9 ± 6.0 dose/ejaculate, respectively. The semen volume, sperm concentration and total number of sperm per ejaculate in cool season were higher ($P < 0.05$) than hot and rainy seasons. The sperm concentration in PC-hybrid boars was higher than Yorkshire boars ($P < 0.05$). The number of extended semen doses per ejaculate in Yorkshire boars was lower than PC-hybrid boars ($P < 0.05$). In conclusions, seasons influence the semen traits of boar kept in evaporative cooling system in Thailand.

Keywords: boar, breed, season, semen, evaporative cooling system

INTRODUCTION

In swine industry, factors that affect the productivity of pigs include management and environment. Fertility of boars depends on semen quality. Factors, such as breed, age, season, temperature and photoperiod are related with the boar semen qualities (Kozdrowski and Dubiel, 2004; Rivera et al., 2005). Earlier studies indicated that season influenced the semen parameters in boars (Marchev and Apostolov, 2004). Photoperiod is one factor, which plays a role on sperm production in mammals via the regulation of melatonin (Tast et al., 2001). Moreover, temperature and humidity are also important climatic factors affecting the boar semen under tropical climates (Kunavongkrit et al., 2005). Monitoring of semen parameters is important for artificial insemination (AI) center (Smital, 2009). The objective of the present study was to investigate seasonal influence on semen production in an evaporative cooling system boar stud in Thailand.

MATERIALS AND METHODS

Data

Data were collected from an AI center in the western region of Thailand, from October 2009 to August 2015. This AI station routinely provides semen for AI in small holder swine herds surrounding the station. A total of 1,870 ejaculates were collected from 44 boars. The breed of boars included Duroc (n=11), Yorkshire (n=15), Landrace (n=15) and crossbred boars (Hybrid Pak-Chong5, PC-hybrid) (n=3). All the boars were trained and identified as proven sires from their fertility data.

Semen collection

The ejaculates were collected using the gloved-hand method. Semen volume (ml) was measured by digital weight scale, the percentage of spermatozoa motility was estimated under a light microscope, at 200× magnification, the concentration of spermatozoa ($\times 10^6$) was measured by Spermacue® (Minitube, Germany). The total number of sperm per ejaculate were calculated from the semen volume \times sperm concentration. Season was classified as cool (15th Oct - 14th Feb), hot (15th Feb - 14th Jun) and rainy (15th Jun - 14th Oct).

Statistical analysis

The data were analyzed by using general linear mixed model procedure of SAS (SAS® version 9.0, NC, USA). The models included breed, year and season of collection as fixed effect. Boar identity was included in the model as a random effect. $P < 0.05$ was regarded to be statistically significant.

RESULTS

The average semen volume, sperm concentration, total number of sperm per ejaculate and number of extended semen dose per ejaculate are presented in Table 1. Breed and season significantly influenced boar sperm quality (Table 2). The effect of season on the semen traits is presented in Table 3. The sperm concentration, semen volume and total number of sperm per ejaculate in cool season was higher than hot and rainy seasons ($P < 0.05$). The result also revealed the effect of breed on the semen parameters (Table 4). The total number of sperm per ejaculate and number of extended semen dose per ejaculate in PC-hybrid boars were higher than Yorkshire ($P < 0.05$) (Table 4). The most common semen volume obtained from the boar ejaculates was 250-299 ml (Figure 1A). Most of the ejaculated semen contained 250-299 $\times 10^6$ sperm/ml (Figure 1B). Moreover, most of the ejaculates had a total number of sperm of 51-60 $\times 10^9$ sperm (Figure 1C). The number of doses after dilution per ejaculate averaged 10-14 dose per ejaculated (Figure 1D). The number of sperm per ejaculate in the boar stud was highest in 2010, sperm concentration was highest in 2013 (Figure 2). Landrace and Yorkshire boars were not affected by season in term of number of sperm per ejaculate, while the sperm output of PC-hybrid and Duroc boars were significantly different among seasons (Figure 3).

Table 1 Descriptive statistics on the semen production in boars kept in evaporative cooling system housing in Thailand

Variables	N	Means \pm SD	Range
Semen volume (ml)	1835	264.6 \pm 93.5	51 – 496
Sperm concentration ($\times 10^6$ sperm/ml)	1848	276.2 \pm 122.6	50 – 809
Total sperm per ejaculate ($\times 10^9$ sperm)	1814	68.1 \pm 28.4	5 – 228
Extended semen dose per ejaculate	1762	15.9 \pm 6.0	1 – 38

Table 2 Factors influencing semen traits of boars kept in evaporative cooling system housing in Thailand

Variables	Breed	Year	Season	Breed x Season
Semen volume	NS	0.095	<0.001	0.002
Sperm concentration	NS	<0.001	<0.001	0.014
Total sperm per ejaculate	NS	0.004	<0.001	<0.001
Extended semen dose per ejaculate	NS	<0.001	<0.001	<0.001

Table 3 Semen production of boars, in different seasons, kept in evaporative cooling system housing in Thailand (least-square means \pm SEM).

Variable	Season		
	Cool	Hot	Rainy
Number of ejaculates	546	713	611
Semen volume (ml)	267.8 \pm 11.3 ^a	248.3 \pm 11.1 ^b	254.9 \pm 11.1 ^b
Sperm concentration ($\times 10^6$ sperm/ml)	295.5 \pm 18.6 ^a	285.1 \pm 18.4 ^b	276.3 \pm 18.4 ^c
Total sperm per ejaculate ($\times 10^9$ sperm)	73.7 \pm 3.8 ^a	66.1 \pm 3.7 ^b	66.2 \pm 3.8 ^b
Extended semen dose per ejaculate	16.0 \pm 0.7 ^a	15.0 \pm 0.7 ^b	14.9 \pm 0.7 ^b

Table 4 Semen production in boars with different breeds kept in evaporative cooling system housing in Thailand (least-square means \pm SEM).

Variable	Boar breed			
	Duroc	Landrace	Yorkshire	PC-hybrid
Number of ejaculates	466	499	685	220
Semen volume (ml)	243.5 \pm 16.7	280.0 \pm 17.0	264.2 \pm 16.1	240.5 \pm 31.9
Sperm concentration ($\times 10^6$ sperm/ml)	289.3 \pm 28.5	252.2 \pm 28.9	250.3 \pm 27.3	350.7 \pm 53.6
Total sperm per ejaculate ($\times 10^9$ sperm)	68.8 \pm 5.7 ^{ab}	66.4 \pm 5.7 ^{ab}	58.0 \pm 5.5 ^b	81.6 \pm 10.8 ^a
Extended semen dose per ejaculate	14.8 \pm 1.1 ^{ab}	14.3 \pm 1.1 ^{ab}	13.8 \pm 1.1 ^b	18.3 \pm 2.0 ^a

DISCUSSION

The present study demonstrated semen production in different genotype of boars in an AI center in the western region of Thailand. Semen from these boars is routinely used for AI in small holder farms surrounding the AI station. A previous study in Thailand also demonstrated that seasons and breed of boar significantly influence semen production of the boars kept in an evaporative cooling system. The total number of sperm per ejaculate was highest during cool seasons. Tretipskul et al. (2012) demonstrated that the seasonal influence on the boar semen production was more evidence in purebred boars than crossbred boars. Saengsukeeluck et al. (2001) found that the average temperature in conventional housing system boar stud was higher than in evaporative cooling systems boar stud in all seasons in Thailand. However, Suriyasomboon et al. (2005) found that the boar semen production did not differ significantly between boars kept in evaporative cooling system and those kept in a conventional open housing system. On average, the semen volume and total sperm production per ejaculation were lowest during hot season. Additionally, the high temperature and high humidity also negatively affect sperm morphology (Suriyasomboon et al., 2005).

In Thailand, ambient temperatures increased during hot season, resulting in a reduction of sow reproductive performance (Tummaruk et al., 2010). When temperatures reach 30°C, spermatogenesis in the boar can be affected. However, individual variations among boars has been reported (Cameron and Blackshaw et al., 1980). In the present study, sperm concentration and the semen volume increased in cool season. Mauget and Boissin (1987) found that the increase in the mass of testes in wild boars was highest in winter, while in summer it was significantly lower, these changes are correlated with

the duration of light period. The increase in the mass of testes results in the increased endocrine activity of testes and therefore high testosterone levels in blood stream (Mauget and Boissin 1987, Weiler et al. 1996). An increased level of sex hormones during autumn and early winter was also reported in the domestic boars (Claus et al., 1983, 1985; Borg et al., 1993). To minimize the adverse effect of season especially during hot period, adequate feeding with high quality diet is suggested (Quiniou et al. 2000). In addition, the management of temperature and humidity using evaporative cooling systems and other techniques that enable AI boar studs to maximize sperm fertility is also recommended (Kunavongkrit et al., 2005).

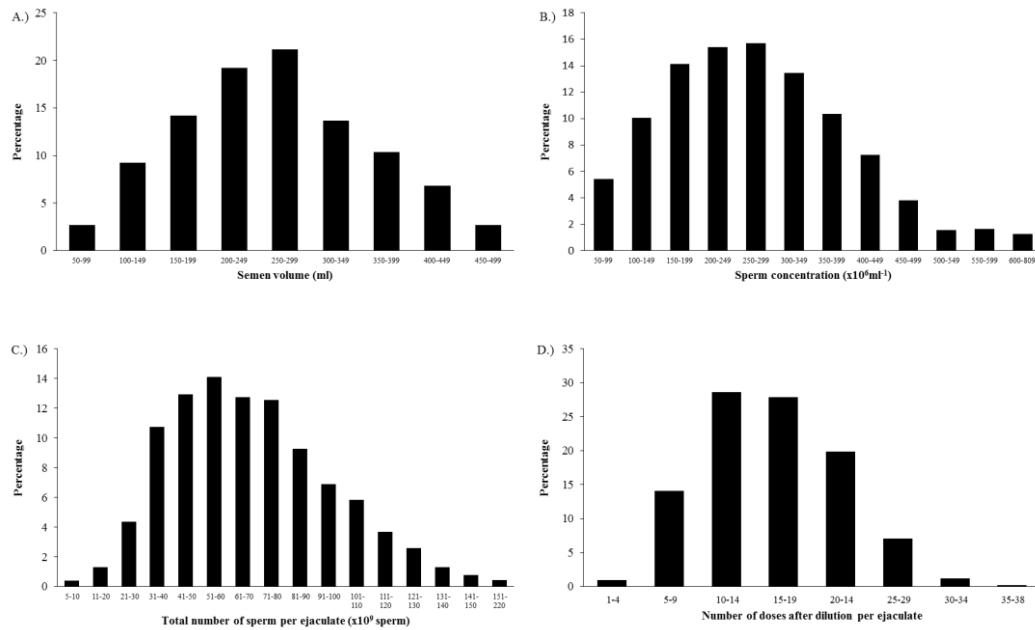


Figure 1 Frequency distribution of the semen production of boars kept in an evaporative cooling system house in Thailand (A.) Semen volume (B.) Sperm concentration (C.) total number of sperm per ejaculate (D.) number of semen doses after dilution per ejaculate

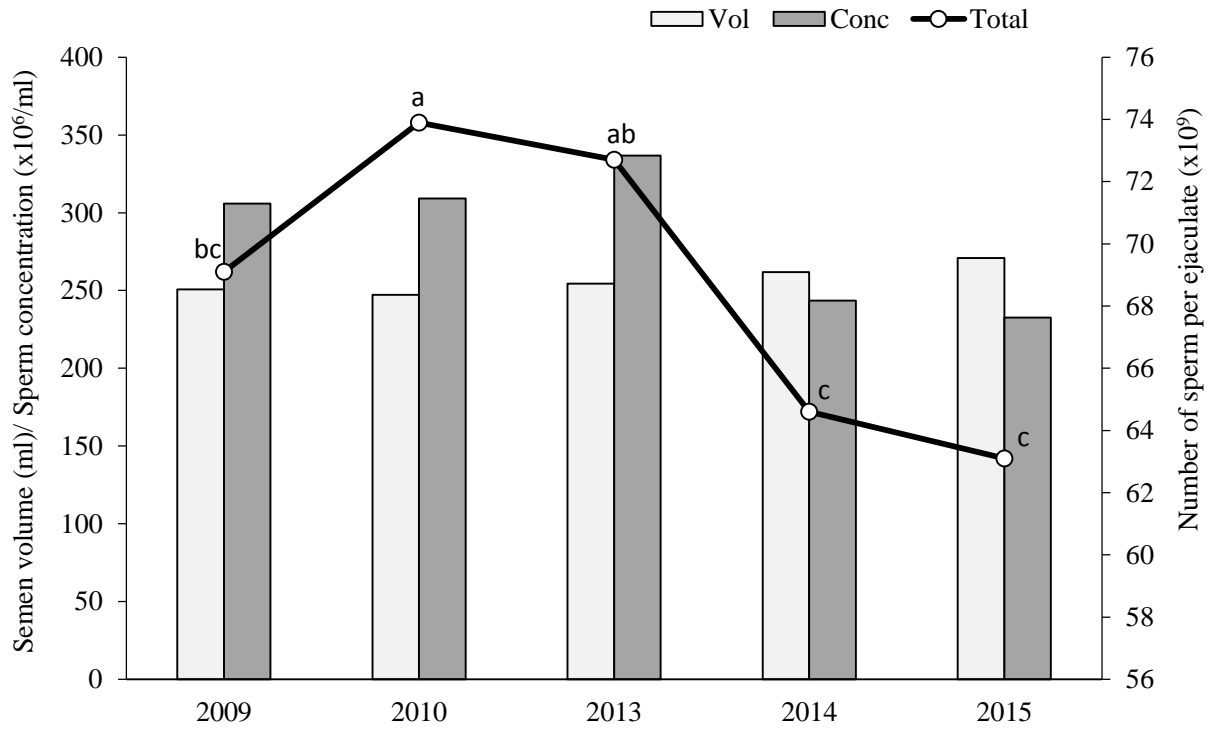


Figure 2 Semen volume, sperm concentration and total number of sperm per ejaculate of ejaculated semen from 44 boars kept in evaporative cooling system from 2009 to 2015 in a boar stud in Thailand

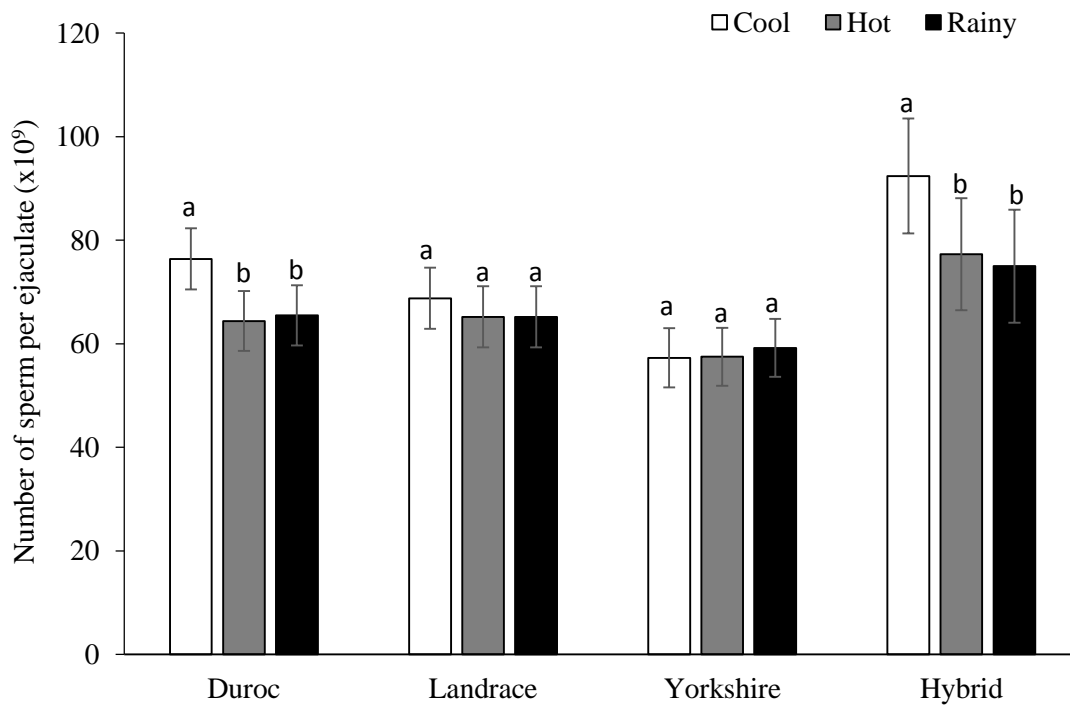


Figure 3 Seasonal variation on the number of sperm per ejaculate in Duroc, Landrace, Yorkshire and Hybrid boars in Thailand

CONCLUSION

In conclusion, seasons influence the semen traits of boars kept in evaporative cooling system in Thailand. The semen volume, sperm concentration and total sperm per ejaculate in cool season were higher than hot and rainy seasons. The total number of sperm per ejaculate and number of extended semen dose per ejaculate in PC-hybrid boars were higher than Yorkshire. Therefore, during hot season, the management of boar stud, e.g., water sprinklers, water drip, ventilation and quality feed intake should be improved to reduce the deleterious effect of heat stress on the boar semen production.

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