



Effect of sow's parity and semen storage time on reproductive performance of pig after artificial insemination with liquid boar semen

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ABSTRACT

Artificial insemination with liquid stored boar semen has considerably improved the pig genetic throughout the world. The present study analyzed the effect of sow's parity and semen storage time on reproductive performance of pig after artificial insemination with liquid boar semen. A total of 218 Gunghroo × Hampshire female pigs including gilts (42) and sows (176) were inseminated with liquid stored semen. Reproductive performance parameters, including farrowing rate, gestation length, weaning to estrous interval, total piglets born, total live piglets born, stillborn piglets, mummified piglets and litter size at weaning were analyzed between different parity and also between different semen storage duration (24 h, 24 to 48 h and 48 to 72 h). There was no effect of parity on farrowing rate. Gestation length was significantly higher in third, fourth and fifth parity as compared to first and second parity. Weaning to estrus interval was significantly higher in first parity. Total piglets born and total live piglets born were significantly higher in third, fourth and fifth parity as compared to first and second parity. There was no effect of parity on stillborn and mummified piglets. Litter size at weaning was significantly higher in third to fifth parity as compared to first and second parity. There was no effect of semen storage duration on farrowing rate, gestation length and weaning to estrus interval. Total piglets born, total live piglets born and litter size at weaning were significantly higher in first group as compared to second and third group. There was no effect of semen storage time on stillborn and mummified piglets. In conclusion, artificial insemination in pig could be successfully used with promising reproductive performance under sub-tropical climatic condition. However, a decrease in litter size was observed when insemination was done with semen stored for more than 24 h.

Keywords: Artificial insemination, Boar semen, Fertility, Parity, Reproductive performance

Pig rearing is practiced by tribals of North East India since ages (Singh *et al.* 2019, Sharma *et al.* 2020). Here, the pig production system is characterized by low input and low output (Singh and Mollier 2016, Singh *et al.* 2019) in which reproductive efficiency is very low (Sharma *et al.* 2020, Singh *et al.* 2020a). Throughout the globe, artificial insemination (AI) in pig has improved the pig fertility, reproductive efficiency and enhanced the genetic improvement (Knox 2016, Singh *et al.* 2021). Artificial Insemination (AI) is a process by which boar sperm are placed into the reproductive tract of a female pig for the purpose of impregnation (Visalvethaya *et al.* 2011, Singh and Mollier 2020). Despite its ages, AI in pig is still the most valuable and useful reproductive biotechnology for introduction of new genetics in pig, with a minimum risk of diseases (Knox 2016, Singh and Mollier 2020). More

than 90% of pigs are being bred by AI in Europe and North America whereas in India hardly 1–2% of pigs are bred by AI (Knox 2016, Singh and Mollier 2020).

The primary reason for the application of AI to the swine industry is to speed up the rate of genetic improvement. This is accomplished by greatly increasing the selection differential, wherein the genetic potential of the best boar can be transferred to a large number of females. AI reduces the numbers of breeding boars to be kept at pig farm, as semen from one boar can be used to inseminate around 2,000 pigs in a year. This enhances the optimum use of the facilities and labour as well as reduced feed supply and medicines (Sharma *et al.* 2020, Singh and Mollier 2020).

Artificial insemination in pig involves use of fresh or liquid stored semen in which three billion sperm are used in one dose (Singh and Mollier 2020). The liquid semen is stored at 17°C for a period of 3 to 5 days depending upon the extender. The storage of liquid boar semen leads to deterioration in its quality because of sperm membrane damage due to reactive oxygen species which is more pronounced in tropical or sub-tropical climate (Atiken and Drevet 2020, Singh *et al.* 2021). This leads to reduced

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Table 1. Effect of sow's parity on farrowing rate gestation length and weaning to estrus interval after artificial insemination

Parity	Numbers of animals inseminated (n)	Numbers of animals farrowed	Farrowing rate (%)	Gestation length (days)	Weaning to estrus interval (days)
First	42	34	80.95 ^a	113.68±0.13 ^b	14.09±0.55 ^a
Second	52	44	84.61 ^a	113.68±0.12 ^b	11.05±0.63 ^b
Third	68	56	82.35 ^a	114.13±0.08 ^a	10.73±0.34 ^b
Fourth	32	26	81.25 ^a	114.27±0.11 ^a	10.31±0.37 ^b
Fifth	24	20	83.33 ^a	114.10±0.12 ^a	9.80±0.42 ^b

Means with different superscript in a column differ significantly (P<0.05).

fertility of liquid stored boar semen. Further, it was reported that parity affects reproductive performance of pigs (Yang *et al.* 2019), whereas, Segura *et al.* (2020) reported no effect of parity on reproductive performance of pig following artificial insemination. Good maternal ability in sows is characterized by large litter size, high piglet growth rate and no piglet mortality (Wulbers-Mindermann *et al.* 2002). The number of live born piglets and litter size at weaning in sows are major reproductive and economic traits. However, there is no published study from sub-tropical region of North East India documenting the effect of sow's parity and semen storage duration on fertility outcome and other reproductive attributes following artificial insemination with liquid stored semen. Therefore, the present study was done to see the effect of sow's parity and semen storage period on reproductive efficiency of Hampshire × Gunghroo crossbred pig.

MATERIALS AND METHODS

The experiment was done at Pig Research Farm of ICAR Research Complex for NEH Region, Nagaland Centre, Medziphema, Nagaland. The climate of the region is sub-tropical with hot humid in summer. The data presented in this article is from April 2019 to March 2021. A total of 218 Gunghroo × Hampshire female pigs including gilts (42) and sows (176) were inseminated. The animals were housed in individual pen and provided commercial pig breeder feed. The farrowing rate was calculated as the proportion of inseminated females that farrowed. Additionally, total piglets born/litter, live-born piglets/litter, stillborn piglets/litter, and mummies/litter were recorded. Gestation duration and weaning to estrus (days) were also recorded.

Semen doses used in this study were collected from boars (Gunghroo × Hampshire) maintained at the research farm. Semen was collected from boars by glove hand method (Singh and Mollier 2020). Semen was transported in thermos flask to laboratory within 15 min of collection. Semen quality parameters were examined in the laboratory. The ejaculates with more than 70% total motility and less than 20% abnormality were selected for use in artificial insemination programme. After examining the semen (macroscopically as well as microscopically), it was diluted in Primxcell (IMV, France) extender. The dilution was done in such a way that each insemination dose (80 mL) contained three billion motile spermatozoa. Processed liquid boar semen was stored at 17°C for three days. Estrus detection

was performed twice daily, using mature boars and the standing reflex in response to back pressure, as well as the presence of reddening and swelling of the vulva. In the gilt, first AI was done on day of estrus detection and second insemination was done 12 h after first insemination. Gilts were inseminated in their third estrous cycle in this study. In sows, AI was done on second day of estrus following AM-PM schedule. Artificial insemination was done using Golden Gilt (IMV, France) catheter.

All statistical analyses were performed using SPSS v.27. Farrowing rate was compared using Pearson's χ^2 test. One way ANOVA was performed to study the effect of sow's parity and semen storage duration on the reproductive performance variables analyzed. The differences between means were determined by Duncan post-hoc test. Quantitative variables were summarized as mean ± standard error of mean (SEM). Differences were considered statistically significant at 95% confidence level (p<0.05).

RESULTS AND DISCUSSION

The present study evaluated the pig fertility after artificial insemination as affected by parity of sow's and semen storage duration. There was no effect of parity on farrowing rate (p>0.05) (Table 1), which are in agreement with Segura *et al.* (2020) and Carney-Hinkle *et al.* (2013). Similar farrowing rate in pig was reported by Singh *et al.* (2020a). Gestation length was significantly (p<0.05) higher in third, fourth and fifth parity as compared to first and second parity. In agreement with our findings, Yang *et al.* (2019), and Estienne and Harper (2010) recorded the higher gestation length in multiparous sows as compared to gilt. Weaning to estrus interval was significantly higher (p<0.05) in first parity. This could be due to fast exhaustion of body reserve in young sows after farrowing as they are still growing and the body reserve is to be partitioned between body growth and reproduction. Similar findings regarding weaning to estrous interval were reported by Singh *et al.* (2020b) in Rani pig. The results of the present study revealed that parity had no effect on success of artificial insemination in Rani pig in terms of farrowing rate and AI could be successfully used in this breed irrespective of the parity.

Total piglets born and total live piglets born were significantly higher (p<0.05) in third, fourth and fifth parity as compared to first and second parity (Table 2). In first few parities, lower ovulation rate and smaller uterine capacity are the possible reasons for smaller litter size than

Table 2. Effect of sow's parity on litter attributes after artificial insemination

Parity	Numbers of animals inseminated	Total piglets born	Total live piglets born	Stillborn piglets	Mummified piglets	Litter size at weaning
First	42	7.12±0.25 ^c	6.65±0.22 ^c	0.35±0.09 ^a	0.09±0.04 ^a	6.15±0.16 ^c
Second	52	9.61±0.20 ^b	8.89±0.20 ^b	0.43±0.09 ^a	0.30±0.07 ^a	8.30±0.13 ^b
Third	68	10.50±0.24 ^a	9.93±0.21 ^a	0.32±0.07 ^a	0.25±0.05 ^a	9.18±0.18 ^a
Fourth	32	11.08±0.36 ^a	10.42±0.29 ^a	0.38±0.09 ^a	0.27±0.08 ^a	9.50±0.23 ^a
Fifth	24	11.35±0.45 ^a	10.55±0.33 ^a	0.50±0.13 ^a	0.30±0.10 ^a	9.55±0.26 ^a

Means with different superscript in a column differ significantly (P<0.05).

Table 3. Effect of semen storage time on farrowing rate, gestation length and weaning to estrus interval after artificial insemination

Semen storage time	Numbers of animals inseminated (n)	Numbers of animals farrowed	Farrowing rate (%)	Gestation length (days)	Weaning to estrus interval (days)
Within 24 h	85	70	82.35 ^a	113.87±0.08 ^a	11.06±0.41 ^a
24 to 48 h	74	61	82.43 ^a	113.89±0.09 ^a	11.28±0.42 ^a
48 to 72 h	59	49	83.05 ^a	114.14±0.11 ^a	11.59±0.46 ^a

Means with different superscript in a column differ significantly (P<0.05).

older sows (Foxcroft *et al.* 2006, Celestin *et al.* 2019). These results corroborate with the report by Niyiragira *et al.* (2018) who observed that the litter size increased with parity. However, Singh *et al.* (2020b) reported lower litter size at birth and at weaning in Rani pig. This could be due to difference in geographical locations and management of pig in the field condition. There was no effect (p>0.05) of parity on stillborn and mummified piglets. This is in agreement with the findings of Segura *et al.* (2020). Litter size at weaning was significantly (p<0.05) higher in third to fifth parity as compared to first and second parity. Total piglets born and litter size at weaning was least in first parity. The study revealed that litter size at birth and litter size at weaning reached maximum at third parity and thereafter remains constant till fifth parity.

There was no effect of semen storage duration on farrowing rate, gestation length and weaning to estrus interval (Table 3). In agreement with our findings, Visalvethaya *et al.* (2011) reported no effect of semen storage on farrowing rate. The results of the present study indicated that liquid stored semen for three days can be effectively used for artificial insemination in pigs without affecting the farrowing rate.

Total piglets born, total live piglets born and litter size at weaning were significantly (p<0.05) higher in first group as compared to second and third group (Table 4). This could be due to deterioration in sperm fertility during liquid

storage. Heat stress because of high temperature humidity index in sub-tropical climate causes poor boar semen quality (Singh *et al.* 2021). It was earlier reported that increasing storage time of AI doses with BTS extender from 4 to 14 h to an interval of 52–62 h caused a 0.5 piglet reduction in litter size for homospermic semen (Haugana *et al.* 2005). Similarly, Dimitrov *et al.* (2009) reported that there was a significant reduction in fertility when the semen was stored for 48 h, while the total number of piglets born and number of piglets born alive significantly decreased after 24 h of storage, which were due to sperm motility and increase of abnormal sperm. The boar sperm have unique membrane composition with low cholesterol to phospholipids ratio which makes it more prone to cryoinjury induced oxidative stress (Aitken and Drevet 2020, Singh *et al.* 2021). There was no effect (p>0.05) of semen storage time on stillborn and mummified piglets. The results of the present study indicate that sperm fertility was maximum within 24 h of semen collection and it deteriorates on further storage.

The results of the present study indicate that farrowing rate did not differ between different parity. However, gestation length was significantly longer in third to fifth parity as compared to first and second parity. Similarly, weaning to estrous interval was higher in gilt as compared to adult sows. Besides, fertility of liquid stored boar semen decreases after 24 h of storage in terms of litter size, however, there was no effect of semen storage duration on

Table 4. Effect of semen storage time on litter attributes after artificial insemination

Semen storage time	Numbers of animals inseminated	Total piglets born	Total live piglets born	Stillborn piglets	Mummified piglets	Litter size at weaning
Within 24 h	85	10.44±0.25 ^a	9.71±0.23 ^a	0.41±0.07 ^a	0.30±0.05 ^a	9.00±0.20 ^a
24 to 48 h	74	9.41±0.29 ^b	8.84±0.25 ^b	0.38±0.07 ^a	0.20±0.05 ^a	8.11±0.20 ^b
48 to 72 h	59	9.45±0.28 ^b	8.90±0.26 ^b	0.35±0.07 ^a	0.20±0.05 ^a	8.18±0.22 ^b

Means with different superscript in a column differ significantly (P <0.05).

farrowing rate. In conclusion, artificial insemination in pig could be successfully used with promising reproductive performance. However, a decrease in litter size was observed when insemination was done with semen stored for more than 24 h.

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