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Effect of artificial insemination and natural mating on reproductive parameters in pigs of warm-humid climate region

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ABSTRACT

Artificial insemination is a popular assisted reproductive technology that ensures transfer of genetic information from animal to animal. This study was meant to evaluate the influence of artificial insemination and natural mating on selected reproductive parameters. Five hybrid females of Duroc-landrace line were selected while 3 boars were used for the mating. Fresh semen was collected from 2 hybrid boars of Yorkshire-Landrace and Yorkshire-Pietrain line and the third boar—a Durocbreed (control) was used to stimulate the sows into oestrus and mate them naturally. Landrace-Yorkshire had shorter time for semen release than Pietrain-Yorkshire breed at first and second time of collecting the semen. Similarly, live born piglets of artificial insemination served 24% higher than natural mating. Therefore, a well-timed artificial insemination method using fresh semen would improve the number of piglets at parturition.

Keywords: Artificial insemination, Climate, Landrace-Yorkshire, Natural mating, Pig, Sperm motility, Yorkshire-Pietrain

The demand for pork consumption has increased consistently with the world population as it takes about 40% of red meat consumed worldwide (Ronald *et al*. 2013). The emergence and development of new reproductive technology in animal production offer farmers of all categories and researchers the opportunity to transfer or preserve genetic information of superior animals; especially males (Cholakkal 2019). Genetic information transferred by farmers are simply driven by the desire to increase the characteristics of the superior animal in their animal for economic purposes such as growth, meat quality, milk production, disease resistance etc. There are many assisted reproductive technologies nowadays, such as artificial insemination (AI), oocyte/embryo cryopreservation, embryo transfer, and nanotechnology. Of these, AI is an option with perhaps less technicality and a technology that is easy to transfer from the developed countries to third world countries, smallholder farmers and useful in different production system. From a single boar, AI will allow farmers to benefit more offspring rather than keeping many boars for natural mating (Romero 2012, Bhave *et al.* 2016). This will reduce financial and nutritional cost of feeding multiple boars. AI permits farmers to derive more output from a boar because of reduced semen volume and sperm concentration used. Globally, there is active competition for new technologies that may directly or indirectly affect the future of animal production, including breeding. Undoubtedly, AI is today the technology of choice used throughout the world to produce pigs.

With AI, 100 doses of semen can be produced from a boar in a month and with intra-uterine insemination there would be an obvious increase in economic efficiency and improved genetics even if the number of sperms per dose of AI is decreased. The growing demand for pork has forced the development of each of the factors of production, which has allowed the progress of breeds specialized in meat production, making AI an important activity for farms in search of greater cost effectiveness compared to natural mating. We hypothesis that we will obtain lower reproductive parameters of less than 50% compared to the natural mating.

MATERIALS AND METHODS

The present work was carried out in the swine post of the Faculty of Agricultural and Environmental Sciences of the Autonomous University of Guerrero, Guerrero, Mexico. The climate is dry hot humid and rain is distributed between May and October. The balanced diet of the pigs was from a commercial feed producer called SAGARPA (FLAGASA® C-460 and FLAGASA® C-450). The lactating sows were fed FLAGASA® C-460 while the pregnant sow and boars were fed FLAGASA® C-450. Five hybrid females of Duroc-landrace line, 20–28 months old with 2–3 body scores were enrolled. Of the 3 boars used, fresh semen was collected from 2 hybrid boars of Yorkshire-Landrace and Yorkshire-Pietrain line which were 9 months old while the

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third boar- a Duroc breed-(36-month-old) was used to stimulate the sows into oestrus and mate them naturally. Fresh semen was used in the AI process. The fresh semen was deposited intra-cervical and the oestrus was detected using the riding technique or lordosis, nose-nose effect. The sows were served 2 times with 80 ml of fresh semen each; either in morning or afternoon when heat was detected and 24 h after heat was detected. The heat of the sows lasted 72 h (Table 2). Fresh semen was collected by gloved hand technique from a boar trained to mount a dummy sow. During farrowing, the sows were given 1 ml of oxytocin to help with uterus contraction in order to facilitate birth process. A thermo-collector was used to collect semen. Semen was subjected to the microscopic and macroscopic evaluation using a 40×100 objective for sperm motility. Other reproductive parameters were measured by counting live born piglets and dead born piglets, as well as the weighing of litters at birth.

RESULTS AND DISCUSSION

Semen quality evaluation: Table 1 result shows the macroscopic evaluation of the fresh semen collected from the two hybrid boars used for AI method. The Yorkshire-Landrace were very fast, released more volume of semen compared to Yorkshire-Pietrain boar. Macroscopic evaluation showed that both semen had similar colour, no odour but were different in transparency. Semen evaluation is very important in AI procedure. This is because the semen/ spermatozoa quality influences the fertilization potential (Tsakmakidis *et al.* 2010). The variation in microscopic and volume concentration among the breeds, may be attributed to the breed difference between them. Breeds influences spermatozoa concentration and sperm volume in an ejaculate as Landrace, Duroc and Yorkshire differ from one another (Kommisrud *et al.* 2002). The volume of semen of both hybrids was within the range described by Kondracki 2003 (100–300 ml). Although crude and subjective, visual evaluation of the opacity of the ejaculate gives a rough idea of the sperm concentration (Dominiek *et al.* 2011).

Table 1. Microscopic and macroscopic evaluation

Boar semen	Microscopic	Volume	Macroscopic	
			Colour	Odour
Yorkshire-Landrace	5 (corkscrew shape)	150 ml	Whitish-milky, without the presence of residues	No odour
Yorkshire-Pietrain	3	120 ml	Whitish-transparent, without the presence of residues.	No odour

0, immobile sperm; 1, Spermatozoids with slow movements without displacements; 2, Spermatozoids with more vigorous movements and almost no or little progression; 3, Spermatozoids with slow movements; 4, Spermatozoa with fast progressions; 5, Spermatozoids with very fast progressive movements (corkscrew shape).

Landrace-Yorkshire semen was less transparent (milky) compared to Pietrain-Yorkshire. Sperm motility is important for fertilization of eggs because it is required to penetrate the zona pellucida (Dominiek *et al.* 2011). The sperm of Landrace-Yorkshire was reported to be faster/more mobile than Pietrain-Yorkshire.

Semen collection time: It was observed that there was a significant difference between collection times of semen between the two hybrids during the two services (Table 2). At first and second instance of semen collection, Yorkshire-Landrace boar produced more semen within short time compared to Pietrain-Yorkshire, which too longer time.

AI service time (*min*)*:* There was no significant difference between the time to first and second service. There was numerical difference at the second service as it was shorter for Landrace-Yorkshire than Pietrain-Yorkshire (Table 3). Time between semen collection from each hybrid boar service and as well as time taken to inseminate them (both times) had no effect on reproductive parameters.

Reproductive parameters: AI significantly influenced the number of piglets (Table 4) which is higher than natural mating (NM). However, average litter weight at birth of AI and NM, and dead born piglets were not influenced by the service method. Similarly, body condition of the female had no effect on the reproductive parameters. It has been documented that farrowing rate and litter sizes achieved using liquid semen can be equal to or better than obtained from natural mating system (Flower and Alhusen 1992). Using a frozen semen result in lower farrowing rates and smaller litter sizes when compared to those achieved using natural service or AI with fresh semen (Estienne 1999). The collection time of Yorkshire-Landrace hybrid boar was faster/ than Yorkshire-Pietrain boar (Table 3). This may be attributed to the higher libido of Yorkshire-Landrace hybrid,

Table 2. Average of semen collection time (min)

Method	TCSP±SE	Pr > |t|	R^2	CV%
1st service				
L × Y	7.33±0.33	<.0001	0.859649	6.792356
P × Y	9.67±0.33	<.0001.	0.859649	6.792356
2nd service				
L × Y	6.67±0.47	0.0001	0.50.	11.13
P × Y	8.00±0.47	<.0001	0.50.	11.13

L × Y, Landrace-Yorkshire; P × Y, Pietrain-Yorkshire; TCSP, Collection time of swine semen/ Collection time second service; SE, Standard error.

Table 3. Average of AI time to service (min)

Method	TIAPS±SE	Pr > |t|	R^2	CV%
1st service				
L × Y	3.00±0.41	0.0018	0.0	23.57
P × Y	3.00±0.41	0.0018	0.0	23.57
2nd service				
L × Y	4.00±0.47	0.0011	0.2000	18.84
P × Y	4.67±0.47	0.0006	0.2000	18.84

L × Y, Landrance-Yorkshire; P × Y, Pietrain-Yorkshire; TIAPS, Artificial insemination time service; SE, Standard error.

Table 4. Reproductive parameter of AI and NM

Method	Parameter±SE	Pr > |t|	R^2	CV%
LNV				
AI	12.40±0.53	<.0001	0.56.	10.56
NM	10.00±0.53	<.0001	0.56.	10.56
PCN				
AI	19.30±1.58	<.0001	0.0001	18.33
NM	19.20±1.58	<.0001	0.0001	18.33
LNM				
AI	0.80±0.22	0.0072	0.167.	83.33
NM	0.40±0.22	0.1114	0.167.	83.33
CC				
AI	2.20±0.20	<.0001	0.00	20.33
NM	2.20±0.20	<.0001	0.00	20.33

AI, Artificial insemination; NM, Natural mating, LNM, Dead born piglets; LNV, Live born piglets; PCN, Average litter weight at birth of IA and NM.

which was observed when riding the dummy, therefore, higher/greater excitation, which caused the release of sperm faster/within a shorter time (Hafez and Hafez 2002). Although, the semen during natural mating was not measured we opine that more than 160 ml would have been ejaculated naturally. This is because board ejaculate more during mating due to excitement based on direct contact with female and stimulation by hormones (Hafez and Hafez 2002). Despite this, live born piglet rate was higher in AI than natural mating. Reproductive performance of AI can be equal or superior to that obtained with the use of the natural mating (Costa *et al.* 2011). Although it is expected that natural mating will yield more live piglet, because during service, a boar is expected to mate when viable ovules are released in each follicular wave (Ortega *et al.* 2002). However, during AI, a well-timed service technique permits us to inseminate at the time closest to the peak of ovulations. This agrees with Feitsma (2009) who reported that when semen is available at the right time to fertilize ova, it could influence litter size. Therefore, this technique needs good knowledge of oestrus cycle and reproductive physiology. The average piglet born through AI is acceptable in a semi-intensive production system. The implication of this is that AI with fresh semen could be used in semi-intensive system in order to increase the economic benefit that could be derived when such piglets are sold after weaning. Despite different service method, there was no difference in the litter weight at birth. This indicate that neither method of service or volume of semen used influence the weight at birth, rather, weight of piglet at birth may be influenced by the genetic factor/value of the boar which sired the piglet. Body score, is important in reproduction, because it could influence incidence of problems such as iron-deficiency anemia, embryo absorption, abortions, premature births as well as litters weight at birth. In this study, body score had no influence on the reproductive parameters.

It can be concluded that, application of AI at the appropriate time (ovulatory peak) would result in better reproductive performance (litter size). Also, service system has no effect on weight of piglet at birth and the livability of the piglet. The average value of piglet born shows that AI could be applied in semi-intensive production system to improve the number of neonates born in order to increase profit that could be made if the piglet is sold after weaning or at the growers' stage.

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