BF-1413
[1-4]

RESEARCH ARTICLE Indian Journal of Animal Research

Semen Viability Properties of Sexually Stimulated Boars on the Fertilization Capacity of Artificially Inseminated Large White Sows

Tshepo Teele

10.18805/IJAR.BF-1413

ABSTRACT

Background: This study aimed to investigate the influences of sexual preparation on the effects of boars' semen viability on the fertilization capacity of artificially inseminated sows. After all, boar sires more pigs than farrowed by a sow which the boar has been mated to improve reproductive parameters in response to AI.

Methods: The semen viability of boars were studied during various sexual stimulations and analyzed during the study period. Sperm rich fractions were collected and separated at every level of sexual stimulation during the morning (08:30) and the afternoon (14:30) hours, respectively. Artificial insemination was performed following three levels of sexual preparations of boars (0 minutes of sexual restraint (MSR), 5 MSR and 10 MSR) before semen collection. Receptive sows were inseminated and evaluated for fertility traits using non-return rate, farrowing rate and litter size.

Result: The non-return rate was recorded as a percentage of sows conceived after insemination over the total number of sows inseminated. The farrowing rate was recorded as a percentage of sows that farrows over the number of sows conceived and litter size as several live piglets per sow. Sexual desire was influenced by sexual preparations and significantly influenced the fertility of the artificially inseminated sows. This study is of practical significance to the animal breeder mainly because boars have greater influence than sows on the average litter size and live piglets. The study concludes that the use of at least 5 to 10 minutes of sexual restraint during the afternoon periods prior to semen collection and artificial insemination is found to be a practical method for optimizing sperm viability and fertility of sows in the intensive system.

Key words: Boar, Fertility, Reaction time, Semen viability, Sexual stimulation.

INTRODUCTION

The sexual drive has been observed as the willingness and eagerness to mount and complete female or dummy service (Levis and Reicks, 2005). The mating ability has been defined as the ability to perform complete service conditioned by the anatomical structure of the male and the copulatory organs (Willenburg *et al*., 2003). Therefore, mating ability presupposes a certain amount of sexual drive. Sexual drive is assessed during semen collection, using reaction time, false mounting and sexual restraint (Kongsted and Hermansen, 2008). Sexual drive is measured by the reaction time (*i.e*., the time in minutes from the introduction of the boar to the teaser to the time of first mounting), using the procedures described earlier by Umesiobi and Iloeje (1999). The three levels of sexual teasing were attained by restraining the boars 20 for zero (0R), 5 (5R) and 10 (R) minutes sexual restraint, respectively, in line with the procedures of Umesiobi and Iloeje (1999). Mounting and prompt ejaculation provided a definite, clearly recognizable endpoint for establishing that a boar was sufficiently sexually stimulated. Changes of stimulus animals and semen collection location were not commonly required to stimulate most boars or maintain their sexual interest during teasing.

The sexual drive responds to endogenous or exogenous stimuli mediated through various physiological mechanisms, learned experience and motivation (Aswathi *et al*., 2019).

Research, Monitoring and Advice Directorate, Council on Higher Education, 1 Persequor Technopark, 1 Quintin Brand St, Persequor, Pretoria, 0020, South Africa.

Corresponding Author: Tshepo Teele, Research, Monitoring and Advice Directorate, Council on Higher Education, 1 Persequor Technopark, 1 Quintin Brand St, Persequor, Pretoria, 0020, South Africa. Email: teele.t@che.ac.za

How to cite this article: Teele, T. (2021). Semen Viability Properties of Sexually Stimulated Boars on the Fertilization Capacity of Artificially Inseminated Large White Sows. Indian Journal of Animal Research. DOI: 10.18805/IJAR.BF-1413.

Submitted: 30-07-2021 **Accepted:** 15-11-2021 **Online:** 06-12-2021

However, the expression of libido is primarily mediated by hormonal events, relationships among blood levels of luteinizing hormone (LH) or testosterone (Knox, 2003). Significant variations in libido have been associated with factors such as genetics, age and experience, nutrition, social environment, inadequate stimuli, temperament, rearing and handling, housing conditions (e.g., crowding and type of floor), type of test, pathologies or traumatic causes and genotype-environment interactions (Landaeta-Hernández *et al*., 2001).

Boar sexual drive is a critical feature of a breeding system in which a predetermined number of females are to

be bred weekly. Sexual drive and semen viability should not be taken for granted, especially during the summer months. Boars are temperamental and individualistic. Some boars possess many desirable traits and are aggressive and fertile; others are sterile or possess no sex drive. Although boars that lack a sex drive are self-eliminating, they cause additional problems because the other boars must be used more frequently to compensate for them. The importance of accurate oestrus detection and correct time of insemination is undeniable. Boar exposure, direct contact and positive sow-sow interaction shortens the weaning-to-oestrus interval, enhances the LH surge and ovulation and increases the likelihood of conception. The mature boar elicits an extreme 'standing' reflex in the oestrual sow. This initial response is generally followed within 20-30 minutes by a refractory or recovery period during which the sow will not respond to further boar stimulation (Loula, 1997; Estienne *et al*., 2000).

MATERIALS AND METHODS

Experimental site and animal management

Twelve Large White boars (aged 2.0 years) and 36 sows of the same breed and age were randomly chosen from a piggery unit at Grootvlei Prisons, Bloemfontein, South Africa. Grootvlei Prison lies at an altitude of 1351 m on latitude 29° 06′ South and longitude 26°18′ East. The experimental boars were trained to mount the artificial sow at 6 to 8 months of age. For the period from October 2018 to September 2019, the experiments were carried out. The research protocols were conducted in 4.5 m × 4.5 m pig pens. Individual pens had a combination of concrete and solid steel rod flooring and were equipped with a nipple waterer. At a 2 kg/day rate, the animals were limit-fed with a fortified corn and soybean meal-based diet that met or exceeded NRC (1998) nutrient recommendations for breeder boars and sows. Diets and a full description of the management practices of the experimental animals have been reported by Umesiobi (2000) and Umesiobi *et al*. (2004). All the measurements were recorded throughout this study period, which lasted for 24 months (October 2018 - September 2019).

Experimental animals and semen collection

The sows used for the AI programme were assigned randomly to the boars subjected to 0MSR, 5MSR and 10MSR treatments to ensure equality among treatments. Semen from each of the boars that were used in this study was evaluated for viability. Semen was collected from boars immediately after 0 minutes of sexual restraint (MSR), 5MSR and 10MSR of sexual preparation at 8h30 and 14h30 diurnal periods, using an artificial vagina device connected to a graduated semen bottle easy semen evaluation and immediately strained through cheesecloth to remove the gelatinous portion. The sperm-rich fraction and the pre-and post-sperm fractions of the ejaculate were collected separately in insulated containers pre-heated to 37°C, as demonstrated earlier by Morrow (2005) and Umesiobi (2008).

Oestrus detection, synchronization and artificial insemination protocol

Since the acceptance of the boar is the best indicator of oestrus in sows, anoestrus expectancy list, based on the previous oestrus of 21 days, was used in detecting sows in oestrus an accurate method of detecting return-to-service sows. Sows in oestrus were detected by exerting pressure on the sacro-lumbar region or sitting in a riding position on the sow's hindquarters. Sows were inseminated 12 to 24 hours after onset of the first oestrus after weaning. Oestrus was synchronized in the experimental sows by a single subcutaneous injection of PG 600R (400 IU PMSG with 200 IU HCG/5 mL dose/animal: Intervet Inc., Millsboro, DE). Sows were checked for oestrus twice daily by providing them with fence-line contact with a teaser boar for a minimum of 15 minutes, beginning 12 hours after the injection of PG 600R. About 72 hours after the PG 600R, all sows were given 1000 IU of HCG (Intervet Inc., Millsboro, DE) to induce ovulation to occur at 40 hours (Umesiobi, 2008). A long catheter (Verona, Minitube Germany Inc.) was used for all the inseminations. A 100 ml of diluted semen was warmed to about 20°C and then injected slowly as far as possible into the cervix. After the onset of oestrus, sows on each treatment were artificially inseminated using semen from the same boars and collections. All experimental females received inseminations of 3×10^9 sperm/80 ml at 12 and 24 h after onset of oestrus. All females were inseminated using a spirette catheter (Minitube Inc., Verona, WI).

Fertilization capacity

Fertilization capacity exemplified by conception rate defined as non-return rate (NRR), farrowing rate and litter size (based on total and live piglets) were recorded. Fertility was defined by Willenburg *et al*. (2003) as non-return rate (NRR) and evaluated as the percentage of sows that conceived (non-return to service sows) over the total number in a flock that was artificially inseminated within a given time lag. Fertility was further assessed by the percentage of sows that farrowed and total piglets (litter size) born per litter.
The following equation was used to estimate fertility:

$$\text{Total fertility (\%)} = \Sigma \text{ NRP} \div \Sigma \text{ IP} \times 100$$

Where,
IP = Total sows inseminated (n = 36).
NRP = Total non-return sows (n = 26).

Statistical analysis

Data were analyzed using the general linear model procedure of SAS (2002 SAS, Version 9.1). The statistical model included sexual restraint classification of boars (0, 5 and 10MSR) and individual boars (breeding boar) within treatment groups. These were analyzed using the Wilcoxon signed-rank test and presented as least-square means (± SE). Fertility estimates were tested by Chi-square analysis (McDonald, 2008). Differences between treatment means were tested for significance.

RESULTS AND DISCUSSION

Semen viability in boars

The semen viability parameters measured in this study were semen volume, motility, semen concentration per millilitre (ml), semen concentration per ejaculate, live sperm, normal sperm and acrosome morphology. There were significantly ($P < 0.05$) influenced by sexual preparations in all treatments studied and demonstrated in Table 1. A significant semen volume increase was obtained during the afternoon following 5MSR (143.33). There was a significant mortality rate increase following 5MSR (72.50) during the afternoon. Semen concentration per ejaculate significantly increased following 10MSR (736.50) during the morning and 5MSR (762.29) during the afternoon. The semen concentration per ml was significant increase during the afternoon following 5MSR (132.93). The significant live sperm rate was obtained during the afternoon following 10MSR (70.83). The normal sperm rate was significantly increased following 10MSR (66.60) during the morning. The normal apical ridge rate was significantly increased following 10MSR (74.33) during the afternoon. The missing apical ridge was significantly reduced following 10MSR (7.66) during the afternoon. There was a significant reduction in the damage apical ridge following 5MSR (6.16) during the afternoon. The loose acrosomal cap was significantly low following 0MSR (3.83) during the morning.

Fertility in sows

As shown in Table 1, the sexual restraint of boars and diurnal period elicited significant differences (P < 0.05) in non-return rate, farrowing rate, litter size and live litter of AI sows. A significant increase in the non-return rate was observed during the afternoon following 5MSR (91.5). The farrowing rate significantly increased following 5MSR (88.3) during the afternoon. The total born piglets or litter size and live piglets were significantly increased following 10MSR (8.5; 7.8) during the afternoon.

This supports Umesiobi (2006) findings that the hypothesis that the intensity of sexual restraint in boars reflects their underlying sexual motivation and provides a meaningful measure of mating competence in sexually experienced boars. It is conceivable that the 5MSR and 10MSR treatments provide an alternative to traditional boar reproductive capacity tests for assessing the libido and fertilizing competence of boars so sexually inactive males can be identified, similar to the findings of Okere *et al*. (2005).

Similar to the findings of Knecht *et al*. (2015) diurnal period effects were more favourable during the afternoon hours; the boars were sexually agile at 14h30 most of the time, during the experimental period. Following the findings of Tsakmakidis *et al*. (2010) and Belkhiri *et al*. (2019), sexual preparation in conjunction with the diurnal period provided an accurate measure for assessing the semen viability through sperm quality and quantity and fertilizing competence of boars. Future research will be necessary to measure the level of relationships between sexual preparation and the reproductive capacity of boars at different ages. Similar to Savić *et al*. (2017), it is evident from this study that sexual stimulation had a significant influence on the fertility of the sows. Suggesting similarly to Flowers (2002) that ejaculates collected from sexually stimulated boars are likely to increase the number of live piglets with significantly improved non-return and farrowing rates. Assessment of effects sexual stimulations could be a better predictor of natural breeding male fertility than semen evaluation. However, harvesting the maximum quantity and quality of spermatozoa is extremely important in artificial insemination (Oberlender *et al*., 2012). Similarly, with the findings of Savić *et al*. (2016), the collected specimen should resemble the ejaculate delivered during intercourse if the male infertility factor is to be properly identified and treated. Seminal characteristics in the various animal species can be influenced by factors such as the frequency of collection,

Table 1: The least-square means (± SE) for boars' semen viability and sow reproductivity traits.

Parameter	Morning (08:30)			Afternoon (12:30)		
	0 MSR	5 MSR	10 MSR	0 MSR	5 MSR	10 MSR
Semen volume (ml)	113.35±13.64^{ab}	116.67±8.82^{b}	112.50±10.70^{ab}	103.23±6.15^{a}	143.33±5.23^{d}	120.81±9.16^{c}
Motility (%)	69.16±3.74^{b}	66.71±2.47^{ab}	60.83±2.39^{a}	63.31±3.80^{a}	72.50±4.42^{c}	70.00±2.58^{b}
Semen con. per ejaculate	655.00±10.45^{a}	702.80±57.14^{b}	736.50±58.53^{c}	680.40±35.36^{a}	762.29±39.10^{d}	670.50± 40^{a}
Semen con. per ml	112.81±2.66^{ab}	113.00±2.77^{ab}	118.85±3.34^{b}	107.83±3.47^{a}	132.93±1.76^{c}	109.55±3.37^{a}
Live sperm (%)	61.67±3.57^{a}	62.17±3.27^{ab}	66.17±2.89^{bc}	60.83±3.26^{a}	67.50±2.14b^{c}	70.83±3.52^{d}
Normal sperm (%)	60.00±2.24^{ab}	63.33±5.1^{c}	66.60±5.11^{d}	60.83±2.71^{ab}	56.67±2.79^{a}	62.50±2.81^{c}
Normal apical ridge (%)	56.50±3.09^{a}	61.20±4.61^{b}	65.67±4.40^{ab}	56.16±4.33^{a}	68.50±7.82^{c}	74.33±3.46^{d}
Missing apical ridge (%)	31.83±12.85^{a}	21.83±5.54^{b}	18.17±6.70^{bc}	16.67±5.26^{c}	25.50±5.90^{ab}	7.66±40^{d}
Damage apical ridge (%)	8.00±1.88^{ab}	15.33±3.22^{a}	7.50±1.28^{ab}	8.65±2.75^{b}	6.16±7.11^{d}	6.48±2.73^{c}
Loose acrosomal cap	3.83±1.09^{d}	9.67±1.72^{ab}	8.68±3.13^{b}	6.00±3.00^{c}	7.00±2.48^{bc}	13.33±2.15^{a}
Non-return rate (%)	40.9±2.2^{a}	50.8±5.3^{b}	65±4.3^{c}	35.6±5.1^{a}	91.5±6.7^{d}	77.5±3.8^{e}
Farrowing rate (%)	41.8±0.3^{a}	53.1±4.2^{b}	59.1±9.2^{c}	48.7±0.5^{ab}	88.3±5.5^{e}	65.3±6.6^{d}
Total born piglets (%)	5.1±0.6^{a}	5.5±0.6^{ab}	7±0.1^{c}	4.1±0.9^{a}	8.0±0.4^{d}	8.5±0.2^{e}
Live piglets (%)	3.2±0.1^{a}	3.5±0.6^{a}	5.5±0.3^{b}	3.1±0.1^{a}	6.4±0.2^{c}	7.8±0.5^{d}

$^{a, b, c, d. e}$ Row means with different superscripts differ significantly ($P < 0.05$); ml= Milliliter; MSR= Minutes of sexual restraint; %= Percentage; 08:30= Morning; 12:30= Afternoon.

degree of stabilization of epididymal sperm reserves and extent of sexual stimulation (Zavos *et al.,*1994).

Since no known change and procedure was introduced during semen collection and insemination, these outstanding and consistent improvements in boar sperm viability. The fertility of artificially inseminated gilts supports the early evidence that the ability of the sperm cells to survive during capacitation in the sow's reproductive tract (Umesiobi, 2006). It may be dependent on the boar's ability in donating optimum quality of semen (Willenburg *et al*., 2003; Umesiobi *et al*., 2004) following sexual restraint (Umesiobi, 2008) and diurnal period (Umesiobi and Iloeje, 1999).

CONCLUSION

Boars sexually stimulated at 5 to 10 minutes during the afternoon hours in the intensive system are most likely to persistently produce optimum sperm viability, with improved conception, farrowing rates, litter size or total born piglets and live piglets from the AI sows. Therefore, this study suggests that using at least 5 to 10 minutes of sexual restraint during the afternoon periods prior to semen collection and artificial insemination of gilts is a practical method for optimizing sperm viability and fertility sows in the intensive system. The mating area should be designed so that the area's concept is to stimulate the sexual behaviour of the male and female pigs by providing both the male and female with better physical conditions at the time of mating. The female with more boar contact at the time of oestrus detection and both the male and female with more sexual stimulation at the time of mating. This study proves that day and sexual restraint are important recommendations to the AI industry and breeders.

REFERENCES

Aswathi, P.B., Bhanja, S.K., Kumar, P., Shyamkumar, T.S., Mehra, M., Bhaisare, D.B., Rath, P.K. (2019). Effect of acute heat stress on the physiological and reproductive parameters of broiler breeder hens- A study under controlled thermal stress. Indian J. Anim. Res. 53(9): 1150-1155.

Belkhiri, Y., Bouzebda-Afri, F. Bouzebda, Z. Mouffok, C.E, Djaout, A. (2019). Seasonal variations in reproductive parameters of Ouled Djellal rams in the East of Algeria. Indian J. Anim. Res. 53(11):1407-1413.

Estienne, M.J., Harper, A.F., Barb, C.R., Azain, M.J. (2000). Concentrations of leptin in serum and milk collected from lactating sows differing in body condition. Journal of Domestic Animal Endocrinology. 19(4): 275-280.

Flowers, W.L. (2002). Increasing fertilization rate of boars: Influence of number and quality of spermatozoa inseminated. Journal of Animal Science, 80(1): 47-53.

Knecht, D., Środoń, S. and Duziński, K. (2015). The impact of season, parity and breed on selected reproductive performance parameters of sows. Arch. Anim. Breed. 58: 49-56. doi:10.5194/aab-58-49-2015.

Knox, R.V. (2003). The anatomy and physiology of sperm production in boars; Published in the website: www.ansci.uiuc.edu/ extension/swinerepronet/Ext Pub/BoarAandP.pdf.

Kongsted, A.G. Hermansen, J.E. (2008). The mating behavior and reproduction performance in a multi-sire mating system for pigs. Theriogenology. 69: 1139-1147.

Landaeta-Hernandez A.J., Chenoweth P.J. and Berndtson W.E. (2001). Assessing sex-drive in young *Bos taurus* bulls. Anim. Reprod. Sci. 31; 66(3-4): 151-60. doi: 10.1016/ s0378-4320(01)00099-9.J.

Levis, D.G. and Reicks D.L. (2005). Assessment of sexual behavior and effect of semen collection, pen design and sexual stimulation of boars on behaviour and sperm output-A review. Theriogenology. 63: 630-642.

Loula, T.J. (1997). Common Mistakes and Solutions in the Breeding Barn. Proceedings of Workshop. Swine Reproduction. Annual Meeting American Association of Swine Practitioners. pp. 19-28.

McDonald, J.H. (2008). Handbook of Biological Statistics. Baltimore, Maryland: Sparky House Publishing, pp. 1-28.

Morrow, M.E.W. (2005). Semen extension: A comparison of methods. Swine News. 28(8): 35-39.

Oberlender, G., Murgas, L.D.S., Zangeronimo, M.G., Silva, A.C., Pereira, L.J. (2012). Influence of ejaculation time on sperm quality parameters in high performance boars. Journal of Animal Science Advances. 2(5): 499-509.

Okere, C., Joseph A., Ezekwe M. (2005). Seasonal and genotype variations in libido, semen production and quality in artificial insemination boars. Journal of Animal and Veterinary Advances. 4(10): 885-888.

Savić, R., Marcos, R.A., Petrović, M., Radojković, D., Radović, Č., Gogić, M. (2017). Fertility of boars- what is important to know. Biotechnology in Animal Husbandry. 33(2): 135-149.

Savić, R., Petrović, M., Radojković, D., Popovac, M., Relić, R., Božičković, I., Radović, Č. (2016). Effect of Photoperiod and Frequency of Ejaculation on Sperm Traits of Boars. Proceedings of the International Symposium of Animal Science, November 2016; 24-25, Belgrade-Zemun, pp. 122-127.

Tsakmakidis, I.A., Lymberopoulos, A.G., Khalifa, T.A.A. (2010). Relationship between sperm quality traits and field-fertility of porcine semen. Journal of Veterinary Science. 11(2): 151-154.

Umesiobi, D.O. (2000). Effect of egg yolk, coconut water and fresh raphia palmwine extenders on the viability of boar sperm during storage at 5°C. J. Agric. Rural Dev. 1(1): 98-106.

Umesiobi, D.O. (2006). Effect of oral administration of Clomiphene citrate on sperm viability and fertility of boar semen. J. Appl. Anim. Res. 30: 167-170.

Umesiobi, D.O. (2008). Measures of servicing capacity of boars and their effects on subsequent fertility in artificially inseminated gilts. Journal of Applied Animal Research. 34: 9-12.

Umesiobi, D.O. and Iloeje, M.U. (1999). Effect of sexual teasing and diurnal period of semen collection on reaction time and semen characteristics of large White boars. J. Sustain. Agric. and Environ. 1(2): 231-235.

Umesiobi, D.O., Kalu, U., Ogundu, U., Iloeje, M.U., Anyanwu, D.C., McDowell, L.R. (2004). Fertility studies on two methods of libido maintenance in West African Dwarf rams. J. Anim. Vet. Advances. 3(2): 81-84.

Willenburg, K.L. Miller, G.M. Rodriguez-Zas, S.L., Knox, R.V. (2003). Effect of boar exposure at time of insemination on factors influencing fertility in gilts. J. Anim. Sci., 81: 9-15.

Zavos, P.M., Kofinas, G.D., Sofikitis, N.V. (1994). Differences in seminal parameters in specimens collected *via* intercourse and incomplete intercourse (*Coitus interruptus*). Fertil Steril. 6(1): 1174-6.