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EFFECTS OF GENOTYPE ON FERTILITY RATES OF MUKOTA, WINDSNYER AND KOLBROEK SOWS

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Background*: Little is known about the temporal relationships between reproductive hormones around oestrus and embryo survival in pigs. Some sows that have been inseminated and are transferred to the gestation units will return to oestrus either because they did not conceive at first service or because they abort during gestation.*

Aim*: This study aims to investigate the effect of pig breeds on fertility rates of Southern African indigenous sows*

Methodologies*: Mukota, Windsnyer and Kolbroek pigs' breeds were subjected to sexual preparation procedures of 0MR, 5MR, 10MR, 15MR, 20MR and 25MR. Sows were inseminated with semen from sexually prepared boars and analysed for fertility rates.*

Results*: Litter size was increased with the afternoon (14:30) protocols in all the breeds studied, with significantly (P<0.05) highest improvement in Windsnyer breed. There were significant improvement in proportions of the litter size amongst experimental groups compared to control groups during the morning (08:30) and afternoon. Farrowing rate was observed higher in Kolbroek (87.50%) followed by Mukota (68.75%) and then Windsnyer (56.25%). Overall, the total average farrowing rate in Southern African indigenous pig breeds studied was observed to be at 70.83%. Total average weaning rate was observed in this at*
87.50% for all studied breeds.

Discussion*: Reproductive traits are of major importance especially in dam breeds of pigs because the reproductive performance of sows is one of the major factors of the breed effectiveness in pig breeding. The breed type has an influence on the willingness of the animal to copulate.*

Conclusion*: Litter size was recorded to have improved with the highest in all studied breeds following 10MR in the afternoon. Moreover, farrowing and weaning rates improved with Mukota recording the highest followed by Kolbroek then Windsnyer.*

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1 INTRODUCTION

Pigs have the highest reproductive rate of any ungulate family. Pigs have large litter sizes, short gestation periods, and early sexual maturity for their body mass (Taylor *et al.*, 1998). However, due to continue demand for meat domestic pigs are exposed to various production systems that might have an impact on their reproductive abilities. One of the areas of interest in monitoring sows' reproductive status is the detection of oestrus. Accepting 5% of the sows not being detected during oestrus (5% false-negative sows), this system could potentially reduce the number of check-ups on sows not (yet) in oestrus to 7.3% of the maximum number of check-ups when no detection system is used (Bresser *et al*., 1994). Embryo mortality accounts for an important part of reproductive losses in pigs.

Little is known about the temporal relationships between reproductive hormones around oestrus and embryo survival in pigs. Some sows that have been inseminated and are transferred to the gestation units will return to oestrus either because they did not conceive at first service or because they abort during gestation. In practice, between 5 and 25% of mated sows will return to oestrus depending on the efficiency on the individual farm (Ostersen *et al*., 2011). The age at first mating (AFM) in gilts is a key factor that determines herd reproductive efficiency (van Wettere *et al.*, 2006) because delayed AFM is associated with low lifetime performance and low longevity of sows.

Infertility can be defined as the inability of a breeding pair to achieve conception or bring a pregnancy (Moslemi & Tavanbakhsh, 2011). Conception in pigs can be achieved within two consecutive mating of two fertile individuals (Umesiobi *et al.,* 2008). Although certain cases of male infertility are due to anatomical abnormalities, such as varicocele, ductal obstructions, or ejaculatory disorders, an estimated 40%–90% of cases are due to deficient sperm production of unidentifiable origin (Moslemi & Tavanbakhsh, 2011). Arrival of fully mature and functionally competent spermatozoa at the site of fertilization is not a random event, but is the culmination of a concert of interactions between sperm cells and the female reproductive tract that optimizes the likelihood of conception. These spermatozoa, which comprise only a small fraction of the inseminate, have completed a long and arduous journey, during which they have surmounted the formidable anatomical barriers within the female tract and have undergone the physiological changes that are required to initiate and complete fertilization (Scott, 2000).

2 Materials and Methods

2.1 Experimental site

Twelve Southern African indigenous boars (aged 2.0- 4.0 years), consisting of Mukota (n=4), Windsnyer (n=4) and Kolbroek (n=4) and forty-eight sows: Mukota (n=16) Windsnyer (n=16) and Kolbroek (n=16). Windsnyer, Kolbroek and Mukota were randomly selected from communal/tribal areas at Qwaqwa in Free State, Transkei in Eastern Cape, Natal, Agricultural Research Council (ARC) Institute in Irene, Gauteng Province, South Africa. The experimental boars were trained and prepared to mount the sows for the false mount procedure for 3 to 6 weeks period. Experimental trials were conducted during the period of March 2013 to October 2015. The research protocol was conducted on traditional home designed pig pens of about 6.0m x 3.5m Area, individual pens flooring were soil ground and water and feed (food by-products and leftovers from the kitchens) provided by the owners daily. Nutritional content of the feeds fed was not determined and not known, 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 the duration of this study period which lasted for 32 months.

The experimental boars were acclimated to the test arena and husbandman for two weeks before the first performance evaluation test. The simulation of 30-min sexual preparation protocols were conducted in a 30-min pen test following zero (0MR), five (5MR), ten (10MR), fifteen (15MR), twenty (20MR) and twenty five (25MR) minutes of sexual restraint at 8h30 and 14h30 diurnal period, and were used to evaluate boar semen and estimate sow fertility using the procedures described earlier by Umesiobi and Iloeje (1999), Umesiobi et al. (2004) and Umesiobi (2008a, b, c). Mounting and prompt ejaculation provided a definite, clearly recognisable end point, for establishing that a boar was sufficiently sexually stimulated. Changes of stimulus animals and semen collection location will not commonly be required to stimulate most of the boars or to maintain their sexual interest during teasing (Teele, 2009).

2.2 Oestrus detection

Individual sows on heat were visually assessed for signs of oestrous twice daily during checkup periods at 08:30 and 14:30 hrs from the third day after weaning onwards. Each sow was tested with the teaser boar from the boar pen to check should a sow showed the standing response when mounted. When the sow had shown oestrus response, during following checkup periods the sow was tested with the backpressure test in absence of the boar before insemination.

2.3 Pregnancy rates

Where farrowing (non-return) rate (FR) was calculated as a percentage of dividing the number of mated (inseminated) sows (MP) over the number of non-return sows (NR), where return rate (RR) was calculated as a percentage of dividing number of return sows (RP) by number of mated sows (MP) as follows:

Farrowing rate*:* $\sum FR = \sum NR \div \sum MP \times 100$

Where:

NR = Total number of non-return (*n* = 34)

Mukota number of non-return (*n* = 11)

Windsnyer number of non-return (*n* = 9)

Kolbroek number of non-return (*n* = 14)

MP = Total number of mated sows (*n* = 48)
Mukota number of mated sows (*n* = 16)
Windsnyer number of mated sows (*n* = 16)
Kolbroek number of mated sows (*n* = 16)
Return rate *(RR)* = $\sum RP \div \sum MP \times 100$
Where:
RP = Total number of return sows (*n* = 14)
Mukota number of return sows (*n* = 5)
Windsnyer number of return sows (*n* = 7)
Kolbroek number of return sows (*n* = 2)

2.4 Litter size
Litter size was calculated as the number of piglets farrowed by a sow following gestation period. From the total number of piglets born the total number of piglets that died were recorded as dead piglets and their rate were determined as mortality rate. Where mortality rate (MR) was calculated as a percentage of dividing the number of dead piglets (DPg) over the number of born piglets (BPg)
Mortality rate *(MR)* = $\sum DPg \div \sum BPg \times 100$
Where:
DPg = Total number of dead piglets (*n* = 12)
Mukota number of dead piglets (*n* = 3)
Windsnyer number of dead piglets (*n* = 5)
Kolbroek number of dead piglets (*n* = 4)

BPg = Total number of born piglets (*n* = 96)
Mukota number of born piglets (*n* = 37)
Windsnyer number of born piglets (*n* = 24)
Kolbroek number of born piglets (*n* = 35)

2.5 Weaning rates
Where weaning rate (WR) was calculated as a percentage of a number of weaned piglets (WPg) divided by the number of born piglets (BPg), where non weaning rate (nWR) was calculated as a percentage by dividing the number of dead piglets (DPg) by the number of weaned piglets (WPg)
Weaning rate *(WR)* = $\sum WPg \div \sum BPg \times 100$
Where:
WPg = Total number of weaned piglets (*n* = 84)
Mukota number of weaned piglets (*n* = 34)
Windsnyer number of weaned piglets (*n* = 19)
Kolbroek number of weaned piglets (*n* = 31)

BPg = Total number of born piglets (*n* = 96)
Mukota number of born piglets (*n* = 37)
Windsnyer number of born piglets (*n* = 24)
Kolbroek number of born piglets (*n* = 35)

Non weaning rate *(nWR)* = $\sum DPg \div \sum WPg \times 100$
Where:
DPg = Total number of dead piglets (*n* = 12)
Mukota number of dead piglets (*n* = 3)
Windsnyer number of dead piglets (*n* = 5)
Kolbroek number of dead piglets (*n* = 4)

2.6 Statistical analysis
Sow parity, number of total born (stillborn or non-wean & live born), number of live born, and equalized litter size was assumed normally distributed and analysed using the MIXED procedure of SAS with treatment as fixed effect (SAS, 2002). Analysis of total born included parity as fixed effect, and analyses of live born and equalized litter size included both parity and total born as fixed effects. The analysis of stillborn piglets the number of total born piglets per litter was included as fixed effect. In addition, the effect of farrowing duration (<5h, 5-9h or >9 h) on stillborn piglets and live born mortality before equalization were analysed. As the data was discrete it was analysed using the GENMOD procedure with an underlying poisson distribution. These models included treatment, parity and total born as fixed effects, and the corresponding interaction terms using procedure described by Hales *et al.* (2015). Estimated least squares means and corresponding SE are presented for the normally-distributed data. For the square root transformed data the back-transformed estimates are presented with a 95% confidence interval and for the poisson distributed data the back-transformed means and SE are as presented. Fertility rates were tested by Chi-square analysis (Snedecor and Cochran, 1980). . Statistical significance was accepted at $P \leq 0.05$ and $P \leq 0.10$ was considered a tendency.

3 Results and discussions

3.1 Effects of genotype on pregnancy rates

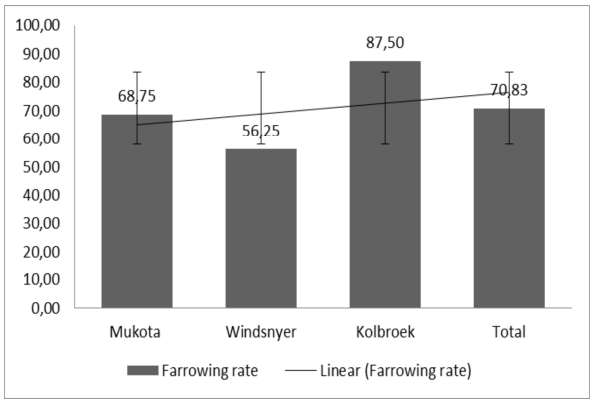

Figure 3.1 Farrowing rates of Mukota, Windsnyer and Kolbroek

Farrowing rate (Figure 3.1) was observed to be higher in Kolbroek (87.50%) followed by Mukota (68.75%) and Windsnyer (56.25%). Overall, 70.83% was recorded as the average farrowing rate in the Southern African indigenous pig breeds studied

3.2 Effects of genotype on litter size

Litter size in Mukota (Fig. 3.2) was influenced following insemination with semen from 5MR to 10MR and declined at 15MR and 20MR while it increased following 25MR during the afternoon artificial insemination procedures with the afternoon semen collection, while it increased following 5MR and 10MR and declined with 15MR, 20MR and 25MR, respectively. Litter size however, was recorded higher following 10MR:14:30 hrs during the afternoon semen collections and the subsequent artificial insemination.

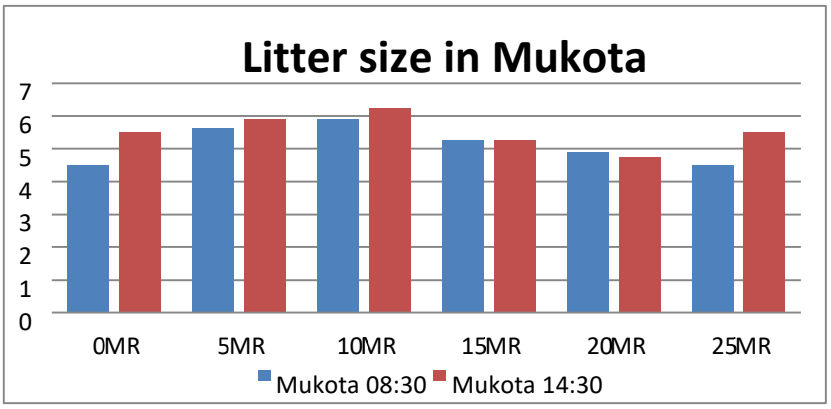

Figure 3.2 Litter size in Mukota following multiple minutes of sexual restraint

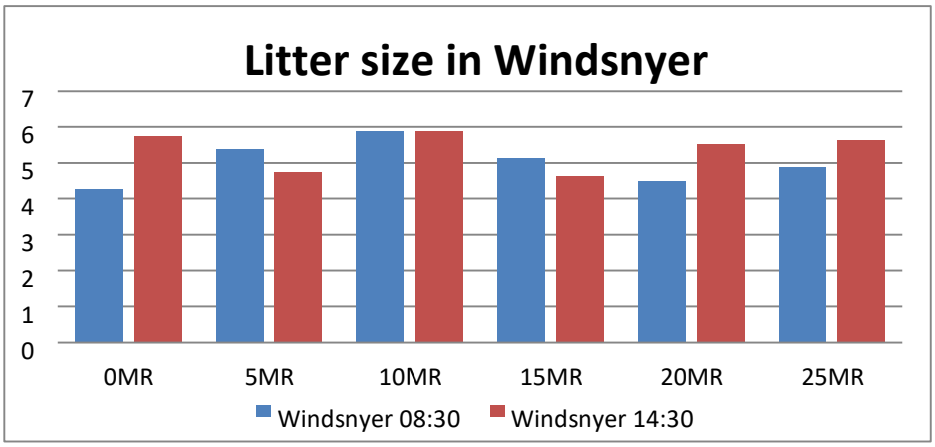

Figure 3.3 Litter size in Windsnyer following multiple minutes of sexual restraint

Litter size in Windsnyer (Figure 3.3) declined following 5MR and 15MR, while it increased following 10MR, 20MR and 25MR, respectively in the afternoon semen collection and artificial insemination, however during the morning litter size increased following 5MR, 10MR and 25MR while it decreased following the 15MR and 20MR respectively. Litter size was recorded higher following the 10MR:14:30 in the afternoon.

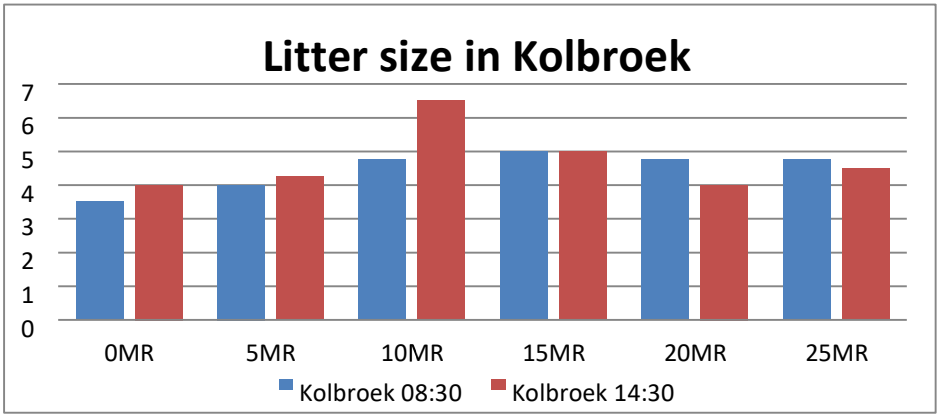

Figure 3.4 Litter size in Kolbroek following multiple minutes of sexual restraint

The Kolbroek litter size (Fig. 3.4) increased following 5MR, 10MR and 25MR and declined following 15MR and 20MR during the afternoon artificial insemination, while during the morning insemination litter size increased following 5MR, 10MR and 15MR respectively and decreased following 20MR and 25MR.

Table 3.1 The least square means (± s.e.) for litter size following zero to twenty-five minutes of sexual (0MR-25MR) restraint and two diurnal periods

Litter size	*Mukota*		*Windsnyer*		*Kolbroek*	
	08:30	**14:30**	**08:30**	**14:30**	**08:30**	**14:30**
0	4,5±2,14	5,5±2,93^{a}	4,25±1,83	5,75±1,04^{a}	3,5±1,29	4±1,83^{a}
5	5,63±2,13^{a*}	5,88±2,03^{a*}	5,38±1,85^{a*}	4,75±1,83	4±1,83^{a}	4,25±1,71^{a}
10	5,88±1,64^{a*}	6,25±2,43^{b*}	5,88±0,99^{a*}	5,88±1,46^{a}	4,75±1,50^{a}	6,5±2,38^{b*}
15	5,25±1,58^{a}	5,25±1,39^{a}	5,13±1,25^{a}	4,63±1,60	5±1,83^{b*}	5±1,41^{a*}
20	4,88±1,36^{a}	4,75±1,67	4,5±2,07	5,5±1,41^{a*}	4,75±2,50^{a}	4±2,16
25	4,5±1,20^{a}	5,5±1,31^{a}	4,88±1,25	5,63±1,77^{a}	4,75±1,50^{a}	4,5±1,29^{a}

^{a,b,c,d,e} *Mean values for each trait with different superscript letters, were different (P<0.05) ;*
=(P<0.01);=(P<0.001)*
** Values are least square means ± standard error*

The least square means (± s.e.) for litter size following zero to twenty-five minutes of sexual (0MR-25MR) restraint and two diurnal periods is tabulated in Table 3.1. There was a significant increase in litter size during the afternoon (14:30) protocols in all the breeds studied, with significantly (P<0.05) highest improvement in Windsnyer breed. There were significant improvements recorded in other treatments throughout the experiments. The results of higher litter size were obtained in Mukota 6.25±2.43, Windsnyer 5.88±1.46 and Kolbroek 6.5±2.38. Interestingly, all the breed highest litter size was from the results obtained following 10MR in the afternoon.

3.3 Effects of genotype on weaning rates

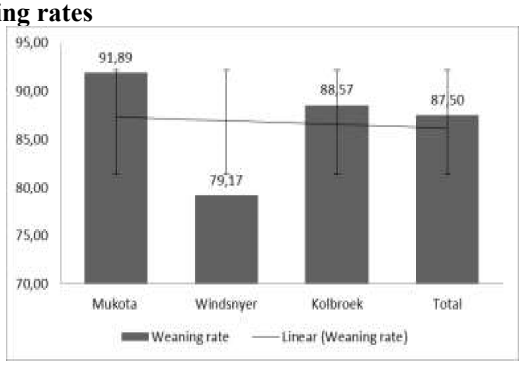

Figure 3.5 Weaning rate in Mukota, Windsnyer and Kolbroek

The proportion of the weaning rate in Mukota, Windsnyer and Kolbroek is demonstrated in Figure 3.5. Highest significant ($P<0.01$) proportion of weaning rate results obtained was observed in Mukota (91.89%) followed by the intermediate proportion of weaning rate in Kolbroek (88.57%) and lastly the lowest proportion in Windsnyer (79.17%). Total average weaning rate was observed in this study at 87.50% ($P<0.05$) for all studied breeds.

4 Conclusion

Highest litter sizes were recorded following 5MR, 10MR and 15MR in studied indigenous pig breeds during the morning and afternoon inseminations. The study suggests that sexual stimulation of the range from 5MR to 15MR during the morning and afternoon provide an ideal endpoint period for sexual preparation of Southern African indigenous pig breeds with the 10MR in the afternoon providing the highest litter size.

5 Acknowledgement

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