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Effect of Timing of Artificial Insemination on Fertility of Cows and Calf Sex Ratio in Arsi Cows

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Abstract

An on-station study was conducted to investigate the effect of the interval between artificial insemination (AI) and the beginning of estrus on the fertility and sex ratio of offspring in Arsi cows. Standing to be mounted was considered the beginning of estrus, and artificial inseminations were made 6 h (Group 1), 12 h (Group 2), 18 h (Group 3) and 24 h (Group 4) after the onset of estrus in the cows. Overall, 50 cows with parity between 2 and 4, body weight ranging from 250 to 300 kg were used for the purpose of this study. Ovulation was synchronized by administration of $PGF_2\alpha$ hormone. Pregnancy diagnosis was performed by rectal palpation at 90 to 120 days post AI. Pregnancy rates were 60%, in each of the Groups 1, 2, 3 and 50% in group 4. The highest female to male ratio (P=0.041) of calves was obtained in Group 1. Whereas the highest male to female ratio was recorded in group 4. The number of artificial inseminations per pregnancy was within the economical limits in all groups. In conclusion, the results of this study indicated that the variation in time interval between the onset of estrus and artificial insemination alters the sex ratio of offspring in Arsi cows without affecting fertility parameters.

Key words: Artificial insemination time; fertility rate; calf sex ratio; Arsi cows

INTRODUCTION

Artificial insemination (AI) has been defined as a process by which sperm is collected from the male, processed, stored and artificially introduced into the female reproductive tract for the purpose of conception (Morrow, 1985; Webb, 2003). When AI was being developed and confirmed, there were several studies that were designed to determine the optimal time of AI in relation to estrus (Aschbacher *et al*., 1956). Figures suggested that optimal pregnancy rate per AI would be achieved from mid-estrus until a few hours after the end of estrus. Since then, the recommended practice has been inseminating cows 12 h after the first observed estrus (a.m.- p.m. breeding). However, because of the variability of interval between the onset and the observation of estrus, it is difficult to define the ideal time of AI in relation to ovulation (**Foote, 1979**).

In Ethiopia, there is high demand for female crossbred calves by dairy producers from artificial insemination services (Bekele, 2005). However, due to different reasons the number of improved heifers in the country is very low.

The use of modified flow cytometry to separate the X and Y sperm populations (sorted sperm), and using the corresponding type to perform AI is a proven and reliable techniques for selecting the gender of offspring. However, it is still the most expensive method for commercial applications (France *et al*., 1992; Seidel *et al*., 1999). Sex ratio manipulation can reasonably improve the effectiveness of selection and genetic improvement programs, through the differential increment of males or females born after Artificial insemination (Seidel, 2003).

Several efforts have been made to alter the sex of calves by varying time of insemination in different breeds of cattle and environments (Pursley *et al*., 1998; Martinez *et al*., 2004). It has been recommended that early inseminations (i.e. far before ovulation) would result in more female calves whereas late inseminations (i.e. close to ovulation) would result in more male calves due to different timing of capacitation and survival time of the X- and Y-chromosome bearing spermatozoa in the female reproductive tract (Martinez *et al*., 2004). However, there is lack of information on suitable insemination time after onset of estrus to alter the ratio of sex in new born calves without affecting fertility of cows in Arsi cattle. Therefore, the objective of the present study was to evaluate the effect of various intervals of AI on the fertility of cows and sex ratio of calves in Arsi cows.

MATERIALS AND METHODS

Study Area

The study was conducted at Adami Tulu Agricultural Research center located at 167km south of Addis Ababa at latitude of 7^0 9′ N and $38^0$7′E longitude in semi-arid middle rift valley of Ethiopia. The area is situated at 1500 meters above sea level and the soil type of the area is fine, sandy loam with sand, clay in the proportion of 34:48:18 respectively. The average annual rain fall is 760mm. The minimum and maximum temperature are 12.6 and 27^0c, respectively (ATARC, 2003).

Experimental Animals, Feeding and Housing

Arsi cows reared on station were selected based on their age, parity and body condition. They were used as a dam line for the study. The semen of Holstein Frisian breed was used as a sire line.

The study was conducted on 50 Arsi cows with parity between 2 and 5 and average body weight of 280 kg. The study was conducted over a period of 18 months (from January 2019 to June 2020). The cows were allowed to graze natural pasture and concentrate supplement was given in the morning and afternoon according to their production level. The animals were housed in free stalls with a concrete slatted floor.

Synchronization, Estrus Detection and Artificial Insemination

Experimental animals were checked for pregnancy through rectal palpation before injecting with hormone $PGF_2\alpha$. Those which were negative to pregnancy test were injected with $PGF_2\alpha$

hormone for synchronization. Estrus was observed by experienced herders and observations were made early in the morning, mid-day, afternoon and mid-night. The onset of estrus was determined when the cows stood to be mounted. A standard semen handling and insemination procedure recommended by IAEA (2005) was used to inseminate animals. Artificial inseminations were carried out by artificial inseminators with standard methodology for cattle. Semen from Holstein Friesian bulls (progeny tested) were deposited in the body of the uterus. The cows were inseminated with frozen-thawed semen 6 h (Group 1), 12 h (Group 2), 18 h (Group 3) and 24 h (Group 4) after the detected onset of estrus. Finally, the cows were examined by rectal palpation for pregnancy between 90 and 120 days after the artificial inseminations. The sex of calves was identified after delivery.

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS 20). Chi-squared tests were used to compare pregnancy rates, the sex ratios of offspring and the number of artificial inseminations per pregnancy. Statistical significance was taken when $P < 0.05$.

RESULTS AND DISCUSSION

Table 1 summarizes the results of sex ratio and fertility parameters. The sex ratios (female/male) were 75/25%, 66.7/33.3%, 50/50% and 80/20% in groups 1, 2, 3 and 4, respectively.

Table 1. The effect of artificial insemination time on the sex ratio of offspring, pregnancy rates and artificial insemination per pregnancy of Arsi cows (n=50)

AI time (Groups)	Pregnancy rate (%)	Sex ratio (%) (female/male)	Number of AI per pregnancy
Group 1 (6 h)	60	75/25[a]	2.02
Group 2 (12 h)	60	66.7/33.3[ab]	1.33
Group 3 (18 h)	60	50/50[ab]	1.5
Group 4 (24 h)	50	20/80[b]	1.6
Overall	58	58.6/41.4	1.7
P value		0.041	

The present sex ratio study showed that there is a significant difference ($P<0.05$) between group 1 and the other groups with the highest female to male ratio was obtained in Group 1. On the other hand, the highest male to female ratio was observed in Group 4. When insemination was carried out beyond 18 h from the onset of the estrus, the percentage of males increased significantly. There was no significant difference ($P>0.05$) in pregnancy rate among the treatment groups. This indicates that it is possible to manipulate the sex ratio of the offspring in Arsi cows with timing of AI without affecting the fertility of cows.

Researchers have reported many conflicting results about the effect of the timing of artificial insemination on the sex ratio of offspring in dairy cows (Rorie *et al*., 1999; Martinez *et al*., 2004). Similar to the present study Martinez *et al*. (2004) reported that the percentage of females in the offspring could be increased by the insemination performed in the first 18 h after the onset of estrus. In contrast, Orkun *et al*., 2005 reported that artificial inseminations performed at

different times in the first half of the estrus period did not alter the sex ratio of offsprings in dairy cows. The difference between the results of these studies could be due to the differences in the breed of animals, in the estrus detection and the quality of semen used for inseminations.

This difference in sex ratio of calves with regard to the time of insemination relative to the estrus on set can be explained by the many physiological differences existing between Y and X spermatozoa. Rohde *et al*. (1973); found that Y chromosome bearing sperms progress more quickly through cervical mucus than those X chromosome bearing sperms. There is a process of sperm selection in the oviduct, in which spermatozoa interact with the oviductal epithelium, forming a reservoir at the uterotubal-isthmus junction undergoing capacitation (Rodriguez *et al*., 2001; Hunter, 2001). Martinez *et al*. (2004) reported that the high percentage of female calves when cows are inseminated within the first 18 h from the onset of estrus can be explained by the fact that Y chromosome bearing sperms in the isthmus would achieve capacitation earlier than X chromosome bearing sperms, released from the oviductal epithelium and reach the fertilization place long before the ovulation.

In the present study there was no significant difference in conception rate between different insemination times. Contrary to the present study, Dransfield *et al*. (1998) found the highest conception rate between 8 and 12 h after the onset of estrus. Although 15 h is within the optimal interval, the difference in pregnancy rate between these results could be due to the difference in estrus detection methods. The mean artificial insemination per pregnancy detected in the present study is within the economical limits advised for healthy herds (Herman *et al*., 1994).

The results of the present study indicate that the percentage of females in the offspring can be increased by performing AI within the first 12 h from the onset of estrus, whereas delaying AI for 24 h significantly increases the percentage of males in Arsi cows.

CONCLUSIONS AND RECOMMENDATIONS

Sex ratio of calves born from Arsi Cows can be manipulated by varying time of artificial insemination without compromising fertility of cows.

The results of the present study indicate that the percentage of females in the offspring can be increased by performing the AI within the first 12 h from the onset of the estrus, whereas delaying the AI for 24 h significantly increases the percentage of males in Arsi cows. Further studies has to be done on other indigenous breeds and crossbred genotypes we have in the country.

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