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Research Article

Comparative Analysis of Estrus Duration and Ovulation Time with and without Copulation in Beetal Goats

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ABSTRACT

Background: The study aimed to assess the impact of copulation on estrus length and ovulation timing in Beetal goats. Methods: Fourteen healthy, multiparous does were synchronized for estrus during the fall breeding season using a CIDR device for 7 days. Each received 5mg of $PGF_2\alpha$ at removal and 50µg of intramuscular gonadotrophin releasing hormone at insertion. The does were split into two groups at random: control (CON; n = 7) and treatment (TRE; n = 7). TRE does undergo two natural copulations within first four hours of estrus expression, while CON does were only mounted by apron-equipped bucks to prevent intromission. Transrectal ultrasonography was performed after every 4 hours following the estrus onset until ovulation. Results: The onset of estrus was similar between groups (41.2±14.8 h in TRE vs. 44.5±11.9 h in CON; P = 0.68). However, the estrus duration was significantly shorter in the TRE group (27.4±4.8 h) than in CON (35.6±5.1 h; P = 0.01). Ovulation occurred earlier in TRE (30.7 ± 2.5 h) than in CON (35.2 ± 3.4 h; P = 0.03). A higher proportion of TRE does ovulated after estrus ended compared to CON (83% vs. 29%; P = 0.04). The number of ovulations per doe did not differ significantly (2.0 ± 0.6 in TRE vs. 2.1 ± 0.5 in CON; P=0.87). Conclusion: In conclusion, copulation significantly shortens estrus and advances ovulation timing in Beetal goats, without affecting ovulation count.

Keywords: Buck, Beetal Goats, Copulation,Estrus, Ovulation.

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INTRODUCTION

Caprine estrus length exhibits great variation (Romano et al., 2016). Estrus duration plays a critical role in the success of artificial insemination (AI) protocols. Insemination of goats is usually advised 12 hours after the onset of estrous and again 12–24 hours later if the goats continue to exhibit estrous behavior (Habeeb & Kutzler, 2021). Previous studies have demonstrated that natural copulation during the early phase of estrus can significantly reduce the length of estrus by 26% to 44%, with durations ranging from 9.3 to 19.2 hours compared to non-mated controls (Romano et al., 2018), (Bottino et al., 2021). Interestingly, this reduction in estrus duration appears to be independent of the number of copulations (Romano et al., 2019).

The mechanism behind this phenomenon has been attributed to mechanical stimulation by the penis against the vaginal fornix (Dubinskaya et al., 2021). When such stimulation was blocked using local and regional anesthesia of the vaginal

and cervical regions, no significant reduction in estrus length was observed despite copulation (Gidena, 2017). Moreover, accessory sexual fluids alone did not influence estrus duration (Romano & Benech, 1996). Notably, fertility outcomes improved when a single copulation by a vasectomized teaser buck was permitted prior to AI, compared to a non-copulated control group inseminated with the same semen (Romano et al., 2000).

While some studies reported no significant differences in ovulation timing or the number of ovulations between copulated and non-copulated goats (Romano & Abella, 1997), assessments were often done at 8-hour intervals, potentially missing subtle but meaningful differences. Reducing the interval between assessments may allow for more precise detection of changes in ovulation dynamics related to mating behavior.

The current study's goal was to assess how copulation affected the length of estrus and the time it took for ovulation in Beetal goats.

MATERIALS AND METHODS

The study was conducted during the fall breeding season at a research farm located in Kot Addu district, under semi-intensive management conditions. Fourteen healthy, multiparous Beetal does, aged between 2.5 and 4 years and weighing 35–45 kg, were selected for the experiment. All animals were clinically normal, cycling regularly, and maintained under uniform nutritional and management conditions. Prior to the study, the does were acclimatized to the handling procedures and teaser bucks for two weeks.

Estrus synchronization was performed using a controlled internal drug release device (CIDR; Eazi-Breed™ CIDR®), each insert containing 300 mg progesterone., which were inserted intravaginally and maintained for 7 days. At the time of CIDR insertion (Day 0), each doe received 50µg of IM gonadotropin-releasing hormone (GnRH). On Day 7, after CIDR removal, 5mg of $PGF_2\alpha$ was administered intramuscularly to ensure luteolysis. Teaser bucks were introduced 24 hours after CIDR removal to initiate estrus detection.

The does were randomly assigned to two groups (n = 7 per group):

Treatment group (TRE): These does were permitted two natural matings with proven fertile bucks within the first 4 hours after the observation of estrus.

Control group (CON): These does were mounted by the same bucks, which were fitted with canvas aprons to prevent penetration.

Estrus detection was conducted at 12-hour intervals during the first 24 hours after CIDR removal, and then every 4 hours for the subsequent 5 days. Estrus was defined as the period during which the doe stood to be mounted by a teaser buck wearing an apron.

Once estrus was confirmed, transrectal ultrasonography was performed using a B-mode real-time ultrasound scanner (e.g., Honda HS-1500, Japan) equipped with a 5–7.5 MHz linear array transducer.) was initiated at 24 hours after estrus onset, then repeated every 4 hours until ovulation was confirmed by the disappearance of preovulatory follicles. Follicular development, ovulation timing, and the number of ovulations were recorded for each doe.

Data collected included estrus onset time (hours post-CIDR removal), estrus duration (hours), ovulation time (hours after estrus onset), and number of ovulations. All ultrasonographic examinations were performed by a trained and same veterinarian to maintain consistency.

Statistical analysis was performed using SPSS IBM 25 software with the 5% level of significance. Differences between treatment and control groups were analyzed using independent samples t-tests for continuous variables and Chi-square tests for categorical data (e.g., proportion of post-estrus ovulations).

RESULTS

All Beetal does expressed estrus following CIDR removal, except one doe from the CON group, resulting in a 100% estrus response in the TRE group and 86% in the CON group detailed results are given in table 1. The mean onset of estrus was not significantly different between the groups, recorded as 41.2 ± 14.8 hours in the TRE group and 44.5 ± 11.9 hours in the CON group (P=0.68). The estrus duration was significantly shorter in the TRE group (27.4 ± 4.8 hours) compared to the CON group (35.6 ± 5.1 hours; P = 0.01).

Likewise, ovulation occurred earlier in the TRE group (30.7±2.5 hours after estrus expression) than in the CON group (35.2 ± 3.4 hours; P=0.03). A higher proportion of does ovulated after the end of estrus in the TRE group (83%) than in the CON group (29%; P=0.04), indicating a significant shift in the timing of ovulation relative to estrus behavior in copulated does.

There was no significant difference in the number of ovulations per doe between the groups, with 2.0±0.6 in the TRE group and 2.1±0.5 in the CON group (P=0.87). No differences were observed in age, body weight, or body condition score (P>0.05).

Table 1. Physiological and reproductive parameters comparison between TRE and CON groups in Beetal goats.

Groups	Does number	Life stage (yr)	Body mass (kg)	BCS	Estrous activity	Latency to Estrus (h)	Estrus Duration (h)	Ovulation Time (h)	% Ovulations After Estrus	Ovulation Rate
CON	7	3.29± 0.5[a]	53.8± 9.8[a]	3.28± 0.5[a]	6	44.5± 11.9[a]	35.6± 5.1[a]	35.2± 3.4[a]	29%[a]	2.1±0.5[a]
TRE	7	3.09± 0.7[a]	52.1± 8.8[a]	3.08± 0.3[a]	7	41.2± 14.8[a]	27.4± 4.8[b]	30.7± 2.5[b]	83%[b]	2.0±0.6[a]

Columns with different superscript letters indicate statistically significant differences ([a],[b] $P<0.05$)

DISCUSSION

The present research investigated, the latency to estrus between the treatment and control groups was comparable and consistent with previous studies utilizing CIDR devices in goats (Romano, 2004). This interval differed from protocols using various progestogens, for example fluorogestone acetate (FGA) or medroxyprogesterone acetate (MAP), which may be attributed to differences in absorption and metabolism among these compounds, as documented in both sheep and goats (Robinson et al., 1967).

Copulation is mandatory to induce ovulation as it is known to provide essential genital stimulation in reflex ovulators such as cats, rabbits, minks (Hafez, 1970), ferrets, camels, alpacas, and llamas (Sumar, 1996). In contrast, goats are spontaneous ovulators, but in these species too, copulation can influence reproductive dynamics. In cows, which are also spontaneous ovulators, sterile service did not affect estrus duration but was shown to prompt a more rapid LH surge and reduce the duration between estrus expression and ovulation (Rande et al., 1975).

In the current study, the effect of copulation during the first 4 hours of estrus significantly shortened the duration of estrus in Beetal does. A reduction of 8.2 hours in estrus duration was observed between the copulated (TRE) and control (CON) groups. This reflects a 23% reduction, supporting the hypothesis that copulatory stimulation reduces estrus length. However, this reduction was modest compared to earlier studies, where estrus duration was shortened by 26% to 46% after mating (Romano et al., 2000), (Romano et al., 2018), (Steverink et al., 1999), (Bottino et al., 2021). While the estrus duration in the TRE group aligns with those reports, the shorter estrus length observed in the CON group in our study may have minimized the apparent difference. Several factors could account for this discrepancy, including breed differences (Beetal vs. Nubian), geographic location, and season (late fall in our study).

Another factor possibly influencing estrus duration in the CON group was the continuous proximity of teaser bucks to the females not just during teasing, but throughout the observation period. In previous experiments, teaser bucks were typically introduced every 6 hours and removed after teasing (Romano, 1993), whereas in this study, they remained nearby, allowing continuous visual, auditory, and olfactory stimulation. Prior research indicates that continuous male exposure after progestin removal can hasten estrus onset in goats (Romano, 1998), and similar male effects have been observed in sheep (Parsons & Hunter, 1967). The role of prolonged male presence without mating in modulating estrus duration deserves further investigation.

This study adds to growing evidence that copulation shortens estrus duration in goats and extends that finding to Beetal goats, an indigenous meat breed not previously studied in this context. This may allow dominant bucks to conserve energy and focus on other receptive females, promoting more effective use of semen and increasing reproductive success across the herd. In controlled breeding systems, especially where artificial insemination (AI) is used, this reduction in estrus duration could allow more precise timing of insemination and reduce the number of AI doses needed.

A key novel finding of this investigation was the significantly earlier ovulation time in the TRE group compared to the CON group, a result that was not previously detected in studies that used 8-hour intervals between examinations (Romano & Benech, 1996). The mean ovulation time in this study was 33.4 hours post-estrus onset, ranging from 28 to 40 hours, consistent with previous reports using laparoscopy, laparotomy, ultrasonography, and slaughterhouse specimens (Greyling, 2000).

In other species, such as swine, natural mating has been shown to shorten the interval from estrus onset to ovulation and reduce the span between first and last ovulation (Knox, 2015). However, in sheep, findings are mixed: some studies report no effect of sterile mating on ovulation timing, others report either a shortening or prolongation of the interval. One study found that continuous exposure to rams after progestin sponge removal hastened estrus onset

and ovulation, without altering estrus duration or the estrus ovulation interval (Landaeta-Hernández et al., 2023).
No significant difference in ovulation rate (i.e., number of ovulations per doe) was found between the TRE and CON groups, which aligns with previous findings where laparoscopy was used to assess ovulation number (Alves et al., 2023). This also agrees with reports in which no difference in litter size was observed between groups copulated by vasectomized bucks and those only mounted, with both groups later inseminated with the same semen (Fatet et al., 2011).
Interestingly, copulation by vasectomized bucks before AI has been shown to increase fertility compared to mounting-only controls, possibly due to enhanced genital tract motility, effects of seminal plasma, or improved synchronization between AI and ovulation (Romano & Abella, 1997). While earlier studies did not find differences in ovulation timing at 8-hour intervals (Romano & Benech, 1996), our results suggest that copulation indeed hastens ovulation, which may better coordinate AI timing with the ovulatory window, potentially contributing to increased fertility. This finding supports reconsidering the role of copulation-induced ovulation acceleration as a key factor in optimizing reproductive efficiency.

CONCLUSION

In conclusion, the results of this study indicate that copulation by a buck at the onset of estrus significantly reduces estrus duration and hastens ovulation in Beetal goats. These findings provide new insights into the physiological responses of indigenous goat breeds to mating stimuli and may contribute to improved breeding strategies in both natural and AI-based systems.

AUTHOR CONTRIBUTIONS

Conceptualization, M. Waqas, and M. Awais Afzal; Methodology, Z. Yousaf, A. Numan, H. Nawaz, A. Masood, H. Hasan and A. Munawar.; Formal Analysis, H. Jamil, S. Umer and R. Kausar.; Writing Original Draft Preparation, M. Waqas.; Writing Review & Editing, M. Waqas and F. Laeeq Lodhi.

COMPETING OF INTEREST

The authors declare no competing interests.

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