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Inducing fertile estrus in hair goats outside the breeding season using just the female-to-female effect

Inducción del estro fértil en cabras de pelo fuera de la temporada reproductiva utilizando únicamente el efecto hembra-hembra

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ABSTRACT

This study aimed to investigate the impact of the female-to-female effect on the fertility traits of does outside the breeding season. In the control group (n= 16 does, 3 bucks), progestogen-containing vaginal sponges were inserted into the does for 11 days, followed by the administration of 500 IU of eCG upon sponge removal. Matings were completed within 36 h after sponge removal. The mated does in the control group were immediately introduced to the female effect group. The does in the female effect group (n= 16 does, 3 bucks) did not undergo any medical procedures. Ultrasound examinations for pregnancy were conducted 30 to 35 days after mating and births were monitored to determine the number of offspring. The control group had a higher estrus rate compared to the female effect group P<0.005). The pregnancy, kidding, and abortion rates in the control and female effect groups were similar (P>0.05). Goats in the female-influence group tended to have a higher multiple birth rate (P=0.059) and numerically higher fertility and litter size compared to the control group, but the differences were not statistically significant (P>0.05). Considering these data, it is concluded that using the female-influence group can induce fertile estrus in goats outside the breeding season, but further studies using larger numbers of goats are needed to compare this method with hormonal methods.

Key words: Estrus; female-to-female effect; goat; pregnancy

RESUMEN

Este estudio tuvo como objetivo investigar el impacto del efecto hembra-hembra en la fertilidad de las cabras fuera de la época reproductiva. En el grupo control (n = 16 hembras, 3 machos), se insertaron esponjas vaginales con progestágeno en las hembras durante 11 días, seguidas de la administración de 500 UI de eCG tras la extracción de la esponja. Los apareamientos se completaron dentro de las 36 h posteriores a la extracción de la esponja. Las hembras apareadas del grupo control fueron introducidas inmediatamente al grupo de efecto hembra. Las hembras del grupo de efecto hembra (n = 16 hembras, 3 machos) no se sometieron a ningún procedimiento médico. Se realizaron ecografías para determinar la gestación entre 30 y 35 días después del apareamiento y se monitorizaron los nacimientos para determinar el número de crías. El grupo control presentó una mayor tasa de celo en comparación con el grupo de efecto hembra (p < 0,005). Las tasas de preñez, parto y aborto en los grupos control y efecto hembra fueron similares (P > 0,05). Las cabras del grupo efecto hembra tendieron a tener una mayor tasa de partos múltiples en comparación con las del grupo control (P = 0,059) y presentaron una fecundidad y un tamaño de camada numéricamente superiores; sin embargo, las diferencias no fueron estadísticamente significativas (P > 0,05). Se concluyó que el estro fértil puede inducirse en cabras de pelo fuera de la época reproductiva mediante el efecto hembra-hembra.

Palabras clave: Cabra; estro; efecto hembra-hembra; preñez

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INTRODUCTION

Alongside the increasing population and food demand, the rising input costs in livestock enterprises necessitate an increase in productivity per animal. The fact that goats enter anestrus during certain times of the year leads to economic losses. Estrus synchronization methods are used to prevent these losses and to plan reproduction. These methods, whether hormonal or non-hormonal, can be used together or separately. The hormones used in estrous synchronization are estrogen, progesterone, GnRH, melatonin, eCG and prostaglandin [1 , 2 , 3 , 4 , 5].

Although there are many hormonal methods, those based on progesterone and eCG are successfully and widely used throughout the year [6]. Non-hormonal methods that can be widely used in the field include supplementary feeding protocols (flushing), the male effect, and the adjustment of light exposure duration [7]. Due to reasons such as the demand for organic farming and the aversion to the use of drugs/hormones in animal production, along with the financial burden of drug and hormone costs on breeders, non-hormonal methods are gaining increasing importance [7].

Social factors are likely important for both initiating and synchronizing breeding activities [8]. Sexual biostimulation is defined as reproductive stimulation provided by one animal to another of the same species [9 , 10] . In sheep (*Ovis aries*) and goats (*Capra hircus*), the sudden introduction of sexually active males into a flock of anestrous females can initiate reproductive activity in the females [11 , 12] . This is referred to as the male (whitten) effect and is commonly used in the field. It has been reported that the presence of estrous females can stimulate ovulation in anestrous ewes or does within the flock [13 , 14 , 15] .This phenomenon is referred to as the "female-to-female effect," since it is facilitated by signals emitted by the female [16 , 17 , 18].

The impact of estrous females on male sexual traits is well recognized in small ruminants [19 , 20]. In addition, the first evidence suggesting that the female-to-female effect can stimulate ovulation in anestrous does was reported by Walkden-Brown *et al*. [13] and this was subsequently confirmed by various studies in the following years [11]. Despite this evidence, there has been a lack of research for many years on stimulating reproduction in anestrous does through the female-to-female effect. Since the 2000s, the few studies conducted on this subject have either examined the female-to-female effect in conjunction with male influence and/or hormone use, or used only one female in estrus [21 , 22 , 23].

Exposure of rams and bucks to estrous females outside the breeding season stimulates them to become sexually active [24]. It has been reported that this interaction causes a sudden increase in LH and testosterone secretion in rams and bucks, and this results in a rapid shift in behavior that stimulates ovulation in females and enhances the likelihood of successful mating [18]. Similarly, it has been demonstrated that ovulations can be induced in anestrous does through the female-to-female effect [13 , 14].

Walkden-Brown *et al*. [13] reported that ovulation was detected in 66.7% of anestrous does exposed to estrous females. However, it has been suggested that unless the female is in breeding condition and receptive, ovulation is not important for breeding timing or synchrony [8]. In goats, it was observed that when the first ovulation coincided with estrus, it reflected a heightened state of reproductive readiness [13] . Therefore, it is important to determine whether the social stimulation of the females induces reproductive conditions (estrus) or merely causes a temporary physiological change (ovulation) [8]. However, in the few studies conducted for this purpose, along with the female-to-female effect, factors such as the male effect and/or hormone usage were examined together [21 , 22 , 23].

The influence of the female-to-female effect on the fertility traits of anestrous goats has remained uncertain. The aim of the present study was to examine the effects of the female-to-female influence on the fertility traits of does outside the breeding season, without the involvement of the male effect or hormone use.

MATERİALS AND METHODS

Ethical approval

The study received approval from the Ethics Committee of Dicle University Health Sciences Education and Research Centre (2023-568849)

Study area and material

The study was conducted outside the breeding season, at the end of April, in a commercial enterprise located at 37°55'01" N latitude, 40°16'46" E longitude, and at an altitude of 660 m in Diyarbakır province, Turkey. The study involved a total of 32 female hair goats, aged between 2 and 4 years weighing 40-45 kg (superscale, yıldırım tartı, Turkey) and 6 bucks. The genital organs of all goats were examined via ultrasound to confirm the absence of pregnancy or estrus.

The animals were randomly divided into 2 groups, each consisting of 16 does and 3 bucks, and placed in two separate semi intensive shelters located 2 km apart. To prevent the male effect, bucks were also present among the does before and during the study, with no treatment applied to them. In addition to grazing on separate pastures during the day, the animals were supplemented with 200 g of lentil straw (*Lens culinaris*) and 300 g of barley (*Hordeum vulgare*) in the evenings.

In the control group (n: 16 does, 3 bucks), progestogen-containing vaginal sponges (Esponjavet, Hipra, Spain) were inserted into the does for 11 days (d), and 500 IU of Pregnant Mare Serum Gonadotropin (eCG) (Ovıser,Hipra,Spain) was administered upon sponge removal. Goats that allowed bucks to approach and sniff their external genitalia were considered to be in estrus. After sponge removal, females in estrus were mated using hand mating. Matings were completed within 36 hours of sponge removal. All females in the control group were transferred to the female effect group immediately after mating and mixed with them. Thus, 16 goats in estrus were included in the female effect group. Females in the female effect group (n: 16 females, 3 males) received no medical treatment. Females in the female effect group were exposed to the "female-female effect" and observed for 7 days, and those in estrus were mated using hand mating. In both groups, pregnancy examinations were performed with ultrasound (Esaote Aquila, Italy) 30–35 days after mating, and births were monitored to determine the number of offspring.

Statistical analyses

Proportional data were analyzed by the chi-square test and numerical data were analyzed by Mann-Whitney U test. Statistical analyses were performed using SPSS 10.0 for Windows (SPSS Inc., Chicago, IL, USA). The results are presented as mean ± SEM. Differences were considered significant at $P < 0.05$, while a tendency was noted for values of $0.05 \leq P < 0.1$.

RESULTS AND DISCUSSION

The results of the study was presented in TABLE I. The control group, which underwent estrus synchronization, had a higher estrus rate compared to the female effect group (100 vs. 56.3%, P<0.005; TABLE I). The pregnancy, kidding, and abortion rates of the control and female effect groups were found to be similar (P>0.05). The does in the female effect group tended to have a higher multiple births rate compared to those in the control group (85.7 and 40.0%; P=0.059) and had numerically higher fecundity (1.44±0.29 and 0.94±0.23; P>0.05) and litter size (1.86±0.14 and 1.50±0.22; P>0.05); however, the differences were not statistically significant. Although there was no statistical difference between our results, the 100% pregnancy rate and the 85.7% multiple pregnancy rate obtained in the female effect group indicate that the method applied resulted in satisfactory pregnancy and lamb birth in goats.

TABLE I
Comparison of fertility traits between the control and female effect groups in hair goats outside the breeding season

	Groups		
Parameters	**Control**	**Female effect**	**P value**
Estrus rate (%)	100 (16/16)	56.3 (9/16)	=0.003
Pregnancy rate[1] (%)	81.3 (13/16)	100 (9/9)	NS
Kidding rate[2] (%)	62.5 (10/16)	77.8 (7/9)	NS
Abortion rate[3] (%)	23.1 (3/13)	22.2 (2/9)	NS
Multiple births rate[4] (%)	40.0 (4/10)	85.7 (6/7)	=0.059
Fecundity[5] (n)	0.94±0.23 (15/16)	1.44±0.29 (13/9)	NS
Litter size[6] (n)	1.50±0.22 (15/10)	1.86±0.14 (13/7)	NS

1: Number of pregnant does /all does mated; 2: Number of does kidding/all does mated; 3: Number of does aborted / number of does pregnant; 4: Number of does with multiple kids / number of does kidding; 5: Number of kids born/ number of does mated; 6: Number of kids born/ number of does kidding; NS: not significant.

Santiago-Miramontes *et al*. [21] observed that exposing anestrous does to estrogen-treated females (in numbers of 10% and 20% of the anestrous population) during male effect exposure stimulated their estrus activity (90 and 93%, respectively). Researchers found pregnancy rates of 45 and 48% in the 10 and 20% groups, respectively. Similarly, Santiago-Miramontes *et al*. [22] reported a significant increase in estrus rates of anestrous does introduced to estrogen-treated females compared to the control group of does (11 and 45%; P<0.05).

Studies of Santiago-Miramontes *et al.* [22] revealed that fertile estrus can be stimulated in does during the anestrus period using the female-to-female effect in conjunction with the male effect. Rodríguez-Martínez *et al.* [23] removed the males prior to the experiment and treated the anestrous does in the eCG group (n=30) with intramuscular eCG, Prostaglandin F2α ($PGF_2\alpha$), and a single dose of progesterone (P_4), while the does in the P_4 group (n=39) were exposed to the females in the eCG group after receiving a single dose of P_4 injection. Immediately after the hormone treatments, all doe groups were introduced to sexually inactive males. Estrus (97 vs. 95%), pregnancy (83 vs. 87%) and kidding rates (63 vs. %64) were found to be similar between the does treated with eCG and the anestrous does exposed to females treated with eCG (P>0.05). However, the does in the eCG group had a significantly higher litter size than those in the P_4 group (1.9 vs. 1.6).

Although similar in design to the study, the study by Rodríguez-Martínez *et al*. [23] includes both the male effect and a single dose of P_4 application. In the study, the does subjected to estrus synchronization exhibited a higher estrus response compared to those exposed to estrous females (100 vs. 56.3%; P<0.05), which is a result that could be expected.

In the study by Rodríguez-Martínez *et al*. [23] the high estrus rate recorded in the P_4 group of does was partially attributed to the male effect. It was suggested that the high estrus response observed in the study may be due to the immediate response of the bucks to the presence of estrous does. The most notable findings of the study were that goats exposed to the female-to-female effect tended to have a higher multiple births rate (85.7 vs. 40.0%; P= 0.059) compared to those in the synchronization group, as well as numerically higher fecundity (1.44 vs. 0.94; P> 0.05) and litter size (1.86 vs. 1.50; P> 0.05). Another notable finding was that all the does exposed to the female-to-female effect and that mated achieved pregnancy. These data clearly indicate that fertile estrus can be stimulated in goats outside the breeding season using only the female-to-female effect.

No similar study was found in the current study. Hogan *et al*. [8] examined the effects of including only one female goat in groups of Saanen females in estrus and noted that none of the females exhibited estrus or ovulation. However, as the researchers noted, this may have been due to the use of only one female goat in estrus. In our study, 16 goats identified as estrus were included with 16 non-estrus goats, and estrus, mating, and pregnancy were achieved through female influence. This demonstrates that a large number of female goats in estrus are required for mating and pregnancy in goats using the female influence method. The intensity of stimulation, determined by the number of males and their libido, was reported to be an important element in triggering ovulation in ewes [25]. When

evaluating the studies conducted, it has been understood that the female effect has two significant positive impacts on anestrous does. The first is its direct effect, which can initiate fertile estrus in anestrous does, while the second is an indirect effect that may arise from making males active and more productive. This indicates that the female effect can be more widely utilized under field conditions in goats to enhance productivity outside the breeding season and to reduce synchronization costs.

CONCLUSIONS

It was concluded from the study that fertile estrus can be induced in hair goats outside the breeding season through the female-to-female effect, without the involvement of the male effect or the use of hormones, nevertheless, to confirm these results, further studies involving a larger number of goats are needed.

Conflict of interest

The authors declare that they have no conflict of interest.

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