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Effect of progesterone-based synchronization protocols with (high cost) or without (low cost) GnRH and gonadotropins early in the breeding season on the fertility of Sanjabee ewe lambs

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Abstract

Effect of a progesterone (P_4)-based synchronization protocol with or without gonadotropins early in the breeding season on the fertility of Sanjabee ewe lambs was investigated. Forty-nine lambs aged 8-9 months received an intravaginal P_4 releasing device (day -14) and allocated randomly to five groups: P_4 Only, no further treatment; P_4PG received $PGF_{2\alpha}$ at device removal (day 0); P_4GnRH received GnRH (day -14) and $PGF_{2\alpha}$ (day 0); P_4eCG and P_4hCG groups were treated as P_4GnRH plus eCG or hCG (day 0), respectively. At day 0, the ewes were introduced to five fertile rams for 7 days. Blood samples were collected on days -14, -1, 2, and 20 for P_4 assay. Progesterone concentrations above one ng/ml on day 20 were considered as pregnancy. Pregnancy status on days 35 and 55 was performed by transrectal ultrasonography. There was no statistically significant difference in embryonic loss on day 35, or in pregnancy rates on days 35 and 55 among the groups. Loss of pregnancy on day 55 was only documented in P_4GnRH (33.3%). Lambing and fertility rates were greatest in P_4eCG (70.0%) and lowest in P_4GnRH (22.2). The highest and lowest prolificacy were observed in P_4eCG (1.14) and P_4GnRH (0.67), respectively. Progesterone concentrations differed within the groups at days -14 and 2 with those at days -1 and 20 ($p \leq 0.05$). In conclusion, adding gonadotropins to a 14-day P_4-based synchronization program early in the breeding season resulted in no significant improvement in reproductive performance of Sanjabee ewe lambs.

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Introduction

Sheep farming is a major component of agricultural activities worldwide. In a context where food security remains a national priority, improving reproductive efficiency in sheep farming is essential (Mouffok *et al.,* 2026). The overall efficiency of sheep production systems is predominantly determined by reproductive performance and subsequent lamb output (Uyanık *et al.,* 2026). Lamb production is important for profitability of any sheep production enterprise and is dependent on the reproductive performance of the flock (Sheikhlou *et al.,* 2020). Among the reproduction variables, prolificacy or litter size is one of the most important factors for the economic profitability of sheep breeding and production (Chong *et al.,* 2019; Calvo *et al.,* 2020). In order to remain profitable, producers aim to optimize efficiency by reducing costs and improving production through increasing lambing rates and year-round production to maintain a steady availability of products (Cabrera *et al.,* 2019). Therefore, there has been a considerable effort to improve reproductive efficiency, with an important factor being the number of lambs born (Juengel *et al.,* 2020). Both age at first lambing and lambing frequency will influence the number of lambings over a ewe's lifetime. These, in turn, are limited by the timing of onset of puberty and the seasonal nature of the sheep reproductive cycle. However, both seasonality and onset of puberty can be controlled by oestrus synchronization protocols, which replicate physiological processes that occur during the natural breeding season (Martinez *et al.,* 2015).

It has been evidenced that ewes bred as lambs produce more lambs than their flock mates bred first as yearlings (Knights *et al.,* 2002). The competition to satisfy market demands, the forage availability and the benefits of a homogeneous lamb crop each year accentuate the need to optimize fertility early in the season. Efforts to hasten the transition period of ewes into cyclicity have involved the use of the ram effect, progesterone (P_4) intravaginal devices, gonadotropins, melatonin implants, photoperiod manipulation, and their combinations (Cabrera *et al.,* 2019). A common oestrus synchronization method in sheep that mimics the luteal phase of the estrus cycle is the administration of P_4 for 12–14 days via an intravaginal P_4-releasing device with or without the administration of equine chorionic gonadotropin (eCG) and/or human chorionic gonadotropin (hCG) at device removal during the breeding and non-breeding seasons (Martinez *et al.,* 2015; Dias *et al.,* 2020). The P_4 source compensates for the absence of active corpus luteum due to a lack of ovulation (Hashem *et al.,* 2023). It has been suggested that gonadotropic support might improve reproductive performance of nulliparous ewes bred during the breeding season (Knights *et al.,* 2015). Conventionally, eCG has been used to stimulate follicular growth and to induce ovulation in ewes during both the breeding and the non-breeding seasons, resulting in pregnancy rates comparable to those when there is natural mating (Silveira *et al.,* 2021).

However, the relatively high costs of hormonal synchronization programs in which gonadotropins, especially eCG and hCG are included, are a major reason that makes farmers unwilling to use such programs. Therefore, the objective of the present study was to investigate the effects of intravaginal P_4 inserts with (high cost) or without (low cost) administration of gonadotropins (eCG or hCG) at the controlled internal drug release (CIDR) device removal on the reproductive efficiency of Sanjabee ewe lambs early in the breeding season. We hypothesized that inserting a CIDR device intravaginally for 14 days combined with eCG or hCG at the device removal early in the breeding season will improve reproductive efficiency in Sanjabee ewe lambs. Sanjabee sheep are the indigenous low-prolific breed in the west of Iran that are raised significantly for meat, skin and wool purposes and have an important impact on the regional economy.

Materials and Methods

All the procedures of the present study were conducted according to the guidelines of the Research Ethics Committee of Razi University, Kermanshah, Iran.

Animals and location

The study was performed on the educational and research sheep farm of Razi University, Kermanshah, Iran, from late summer to late winter of 2019 and 2020. The animals were kept on natural grazing and in barns with open-air and roofed buildings, had free access to fresh water,

and fed a diet that had been adjusted to provide their requirements. The reproductive tracts of the ewe lambs were examined by inspection and ultrasound for the evidence of any abnormalities before initiation of the experiment. Fifty five Sanjabee ewe lambs aged between 8 and 9 months were used in the present study. The animals had no contact with any ram at least during the past 6 to 7 months.

Experimental design

All animals received a controlled internal drug release (CIDR; 0.33 g P_4; The Research Center of Polymers and Petrochemistry, Tehran, Iran) device which has been fitted for intravaginal insertion in small ruminants (Cabrera *et al.,* 2019; Roshan *et al.,* 2023), at the beginning of the experiment (day -14), which was withdrawn 14 days later (day 0). At day 0, the animals allocated randomly to the experimental groups with an approximately equal body condition score distribution. P_4 Only (n = 11): the animals received no further treatment and the devices were removed after 14 days (day 0); P_4PG (n = 11): the animals received a dose of d-cloprostenol sodium (125 µg, D-clo PG, 10-ml vial, 0.025 mg/ml, Royan Darou Co., Veterinary Division, Semnan, Iran) intramuscularly at day 0 for luteolytic purposes; P_4GnRH (n = 11): the animals received a dose of GnRH (25 µg, Vetaroline®, 10-ml vial, 5 µg/ml Alarelin acetate (Luliberin- A), Aburaihan Pharmaceutical Co., Tehran, Iran) at day 14 for stimulating the emergence of follicular waves and a dose of d-cloprostenol sodium at day 0; P_4eCG (n = 11): the animals were treated as P_4GnRH plus 500 IU of eCG (500 IU, GONASER®, PMSG (eCG), vial 5000 IU, HIPRA, Spain) at day 0 for promoting further follicular development and induction of ovulation; P_4hCG (n = 11): the animals were treated as P_4GnRH plus a dose of hCG (500 IU, Karma-HCG®, vial 5000 IU, BSV BioScience GmbH, Germany) at day 0 for inducing ovulation. All ewe lambs were introduced to fertile rams at a ram to ewe ratio of 1:7-10, 12 hours after CIDR removal for 7 days and separated from the rams at the end of the 7-day period. The ewe lambs were again introduced to the rams 14 days later, so that those ewe lambs that had not been mated or conceived to be mated on returning to estrus. During the study period, six ewe lambs were excluded from the study because of illness and receiving pharmacologic treatments; therefore, the data of these animals were excluded from the final analyses and the data of only 49 animals that were complete were used for analyzing.

Blood sampling and hormone assays

Blood samples (10 ml) were collected from the jugular veins of all ewe lambs by jugular venipuncture into non-heparinized vacuum blood collection tubes on days -14, -1, 2, and 20, and properly labeled with the corresponding animal identity and collection day. The blood samples were transmitted to the laboratory of the faculty immediately after collection and were allowed to coagulate in a place with a cool temperature for 2 hours. Then, the samples were centrifuged at 3000 × *g* for 15 minutes and the sera obtained were stored at -20˚C until hormone assay. Serum P_4 concentrations assay was performed by ELISA method using commercial P_4 kits (Sensitivity: 0.12 ng/ml; Progesterone Monobind, Inc. Lake Forest, CA, 92630 USA, 4825-300A). The intra- and inter-assay coefficients for the kits were 6.5% and 7.2%, respectively.

Pregnancy diagnosis

The pregnancy or non- pregnancy status of the ewe lambs on day 20 was judged based on blood P_4 concentrations of the blood samples collected at day 20. A ewe lamb was considered pregnant if the corresponding P_4 concentrations were above 1 ng/ml (de Brun *et al.,* 2016). Pregnancy diagnosis on day 35 was performed by transrectal ultrasound (ULTRASONIC SCANNER, MODEL: HS-1500V, SN: 70610484, HONDA ELECTRONIC CO. LTD 20 OYAMAZUKA OIWA-CHO, TOYOHASHI, AICHI, JAPAN) using a 7.5 MHz linear transducer stiffened with a hollow aluminum rod to determine the pregnancy rate (PR) and the embryonic loss rate (ELR) and on day 55 to determine the pregnancy loss rate (PLR) of the groups.

Data collection

The data that were collected included conception rate (CR): the number of the pregnant ewe lambs in a group on day 20 after the device removal based on blood P_4 concentrations (> 1 ng/ml) divided by the overall ewe lambs in the corresponding group × 100 (de Brun *et al.,* 2016); ELR on day 35: the number of the pregnant ewe lambs in a group on day 20 based on blood P_4 concentrations (> 1 ng/ml) minus the pregnant ewe lambs in the corresponding group on day 35 based on transrectal ultrasonographic

examination divided by the number of the pregnant ewe lambs on day 20 based on blood P_4 concentrations (> 1 ng/ml) in the corresponding group × 100 (Hashem *et al.,* 2015); PR on day 35: the number of the pregnant ewe lambs on day 35 based on transrectal ultrasonographic examination divided by the total ewe lambs in the corresponding group that introduced to rams after CIDR removal for 7 days × 100 (EL-Mokadem *et al.,* 2020); PLR: the number of the ewe lambs that were diagnosed to be non-pregnant on day 55 based on transrectal ultrasonographic examination divided by the number of the pregnant ewe lambs on day 35 in the corresponding group × 100 (Hashem *et al.,* 2015); LR: the number of the ewe lambs that lambed in a group divided by the total number of the ewe lambs in the corresponding group × 100 (Habibizad *et al.,* 2015; Swelum *et al.,* 2015); fecundity rate (FR): the number of the lambs born to the ewe lambs in a group divided by the total ewe lambs in the corresponding group × 100 (Hashem *et al.,* 2015; Swelum *et al.,* 2015); twinning rate (TR): the number of the ewe lambs that lambed twins in a group divided by the pregnant ewe lambs in the corresponding group × 100 (Swelum *et al.,* 2015); prolificacy (Prol): the number of the lambs born in a group divided by the total ewe lambs lambed in the corresponding group (Swelum *et al.,* 2015); abortion rate (AR): the number of the ewe lambs in a group that aborted divided by the pregnant ewe lambs in the corresponding group × 100 (Swelum *et al.,* 2015).

Statistical analysis

Data were analyzed using SAS® software (Statistical Analysis System, Release 9.4. Cary, NC, USA: SAS Inst. Inc.) by logistic regression method using Proc Genmod for determining the probability of significant differences between the treatments and occasions. $\chi 2$ square statistics was used to determine the degree of difference between the groups. The level of significance was set at $p \leq 0.05$.

Results

CR on day 20

CR on day 20 after CIDR removal based on blood P_4 concentrations was greatest in P4eCG and least in P_4GnRH (90% and 55.5%, respectively), but the difference was not significant ($p = 0.3139$) (Table 1).

Table 1. Results of the reproductive variations of the Sanjabee ewe lambs synchronized with CIDR, GnRH, PGF2α, eCG and hCG early in the breeding season.

Variable	P_4Only	P_4PG	P_4GnRH	P_4eCG	P_4hCG
CR*(%)	7/10 (70.0)[a]	9/11 (81.8)[a]	5/9 (55.5)[a]	9/10 (90.0)[a]	5/9 (55.5)[a]
ELR (%)	4 (57.1)[b]	2 (22.2)[b]	2 (40.0)[b]	2 (22.2)[b]	1 (20.0)[b]
PR (%)	3 (30.0)[c]	7 (63.6)[c]	3 (33.3)[c]	7 (70.0)[c]	4 (44.4)[c]
PLR (%)	0 (0.0)[d]	0 (0.0)[d]	1 (33.3)[d]	0 (0.0)[d]	0 (0.0)[d]
LR (%)	3 (30.0)[e]	7 (63.6)[e]	2 (22.2)[e]	7 (70.0)[e]	4 (44.4)[e]
FR (%)	3 (30.0)[f]	7 (63.6)[f]	2 (22.2)[f]	7 (70.0)[f]	4 (44.4)[f]
TR (%)	0 (0.0)[g]	0 (0.0)[g]	0 (0.0)[g]	1 (10.0)[g]	0 (0.0)[g]
Prol	1[h]	1[h]	0.67[h]	1.14[h]	1[h]
AR (%)	0 (0.0)[i]	0 (0.0)[i]	0 (0.0)[i]	0 (0.0)[i]	0 (0.0)[i]

P_4Only: CIDR in,14 days, CIDR out (day 0); P_4PG: CIDR in, 14 days, CIDR out + PGF2α; P_4GnRH: CIDR in + GnRH, 14 days, CIDR out + PGF2α; P_4eCG: CIDR in + GnRH, 14 days, CIDR out + PGF2α + eCG; P_4hCG: CIDR in + GnRH, 14 days, CIDR out + PGF2α + hCG.*AR: abortion rate; CR: conception rate on day 20 based on serum progesterone concentrations; ELR: embryonic loss rate on day 35 ± 1; FR: fecundity rate; LR: lambing rate; PLR: pregnancy loss rate on day 55 ± 1; PR: pregnancy rate on day 35 ± 1; Prol: prolificacy; TR: twinning rate.[a] Means bearing different superscripts in the same row differ significantly ($p \leq 0.05$).

ELR on day 35

The highest and lowest ELRs on day 35 based on transrectal ultrasonographic examination were observed in P_4 Only and P_4hCG, respectively, but the difference was not significant ($p = 0.6491$) (Table 1).

PR on day 35

According to the results, the highest and lowest PRs on day 35 based on transrectal ultrasonographic examination were observed in groups P_4eCG and P_4 Only, respectively, but the difference between them was not significant ($p = 0.2645$) (Table 1).

PLR on day 55

PLR on day 55 after CIDR removal based on transrectal ultrasonographic examination was 33.3% in P_4GnRH and 0% in other groups, but the differences were not significant ($p = 0.4803$) (Table 1).

LR

The results demonstrated that the greatest and least lambing rates occurred in P_4eCG (70.0%) and P_4GnRH (22.2%), respectively, but the difference was not significant ($p = 0.1280$) (Table 1).

FR

According to the results, the highest and lowest number of lambs born occurred in P_4eCG (70.0%) and P_4GnRH (22.2%), respectively, but the difference was not significant ($p = 0.1280$) (Table 1).

TR

Overall, one twinning (10.0%) occurred among all animals used in the present experiment and it happened in P_4eCG. The difference between this group and the others was not significant ($p > 0.05$) (Table 1).

Prol

The results showed that the highest and lowest prolificacy were in P_4eCG (1.14) and P_4GnRH (0.67), respectively, but the difference was not significant ($p = 0.1280$) (Table 1).

AR

There occurred no abortion in the ewe lambs used for the present experiment ($p > 0.05$) (Table 1).

Hormone assay

According to the results, the blood P_4 concentrations (mean ± SD) were as shown in Table 2. The differences in mean ± SD concentrations at each time point (days -14, -1, 2, and 20) did not differ between the groups ($p > 0.05$), but the difference in P_4 concentrations on days -14 and 2 differed with those on days -1 and 20 within the groups ($p \leq 0.05$).

Discussion

In the present study, fall-born ewe lambs aged 8 to 9 months were treated with CIDR that was left in place for 14 days, with (high cost) or without (low cost) GnRH at the device insertion, and PGF2α, eCG, and hCG at the device removal in order to find a less expensive method of improvement of reproductive performance in Sanjabee ewe lambs, since incorporating hormones such as gonadotropins can increase costs of reproductive management and decrease farmers' willingness to use such programs. The results showed that although numerical improvements were observed in the rates of conception, pregnancy, lambing, fertility, and twinning, as well as prolificacy of P_4eCG group, in which the animals received 500 IU of eCG at CIDR removal compared to others that did not receive eCG, treatment did not affect these variables significantly. In addition, there was no effect of treatment on the blood P_4 concentrations at all time points examined. This finding is in agreement with the results of Dovolou *et al*. (2013) who found no difference in P_4 concentrations between groups of virgin ewes synchronized with progestagen-impregnated intravaginal sponges that remained in situ for 8 days and administering PGF2α a day before and eCG at sponge removal at all time points examined after sponge removal. In addition, Hasani *et al*. (2018) reported that pregnancy and lambing rates of the first estrus as well as blood P_4 concentrations were not affected in Ghezel ewes by three different types of treatments including progestogen sponge for 12 days + eCG at the time of sponge withdrawal, two doses of cloprostenol with a 12-day interval, and cloprostenol + eCG at day 12. In contrast, Zeleke *et al*. (2005) reported that treatment of ewes with intravaginal progestagen sponges during the transition into the anestrous period and administration of eCG at or one day before progestogen withdrawal resulted in greater lambing rates compared to those administered 24 hours after sponge withdrawal or those not received eCG. Dias *et al*. (2015) reported that the mean P_4 concentrations in ewes before insertion of an intravaginal P_4 releasing device during the reproduction season were less than 1 ng/ml, but increased after device insertion and remained above 2 ng/ml during the period in which the device was in place, averaging 5.09 ± 0.49 ng/ml in those ewes that received new intravaginal P_4 releasing device. The values again reached below 1

ng/ml after device removal. The findings of the current study are consistent with those of Dias *et al*. (2015). It has been evidenced that upon removal of the CIDR, P_4 concentrations in circulation decrease allowing for initiation of estrus and associated physiological processes (Rosasco *et al.,* 2019). However, the results of the present study showed that within the groups, the concentrations of P_4 on days -14 and 2 differed significantly with those on days -1 and 20 ($p \leq 0.05$).

Table 2. Serum progesterone concentrations (mean ± SD; ng/ml) on different days during the study period in Sanjabee ewes.

Groups	P_4Only	P_4PG	P_4GnRH	P_4eCG	P_4hCG
Day -14	0.7 ± 0.14[a]	0.80 ± 0.10[a]	0.60 ± 0.6[a]	0.4 ± 0.25[a]	0.60 ± 0.16[a]
Day -1	5.10 ± 0.22[b]	5.18 ± 0.16[b]	5.02 ± 0.23[b]	5.24 ± 0.25[b]	5.06 ± 0.16[b]
Day 2	0.34 ± 0.02[a]	0.40 ± 0.10[a]	0.32 ± 0.20[a]	0.24 ± 0.01[a]	0.36 ± 0.16[a]
Day 20	5.08 ± 0.22[b]	6.18 ± 0.16[b]	4.42 ± 0.23[b]	6.04 ± 0.25[b]	4.76 ± 0.16[b]

P_4Only: CIDR in,14 days, CIDR out (day 0); P_4PG: CIDR in, 14 days, CIDR out + PGF2α; P_4GnRH: CIDR in + GnRH, 14 days, CIDR out + PGF2α; P_4eCG: CIDR in + GnRH, 14 days, CIDR out + PGF2α + eCG; P_4hCG: CIDR in + GnRH, 14 days, CIDR out + PGF2α + hCG. [a] Means bearing different superscripts in the same row differ significantly ($p \leq 0.05$). [a] Means bearing different superscripts in the same column differ significantly ($p \leq 0.05$).

In the present study, 500 IU of eCG was administered to the ewe lambs in P_4eCG at CIDR removal (day 0), which resulted in 70.0% lambing rate. Lambing rates in other groups that did not receive eCG at CIDR removal were between 22.2% and 63.6%, however, the differences were not significant. The increase in LR in P_4eCG was because of an increase in the proportion of lambing ewes, since only one ewe had twin birth. Whereas, in the study by D'Souza *et al.* (2014), it was reported that increase in LR was due to increases in both lambing and prolificacy proportions of ewes. The discrepancy between the current study and that of D'Souza *et al.* (2014) may be due to the differences in the age and breed of the animals used in the two studies, since prolificacy enhances as the parity of the animal increases. In addition, in the study by D'Souza *et al.* (2014) a mixture of eCG and hCG was administered to the treatment group one day before or at the time of device removal, while in the present study, eCG and hCG were administered separately to different groups at the time of device removal. In a study by Keefe and Wichtel (2000), PRs in parous ewes treated with medroxyprogesterone acetate sponge for 13 days with or without administration of eCG at the time of sponge removal out of the breeding season differed significantly (66.7% vs. 16.7%, respectively). In the study by Martinez *et al.* (2015), it was reported that PRs of Dorset-cross sheep (60.7%) treated with an intravaginal P_4-releasing device for 7 days, administration of a GnRH analog at device insertion, and eCG and a PGF2α analog at device removal and of those (56.5%) that treated with intravaginal P_4-releasing device for 12 days and eCG at device withdrawal were significantly greater than that (43.4%) in the untreated control group out of the breeding season. The authors also demonstrated an effect of age and treatment on the proportion of pregnant sheep and twin pregnancies, so that the proportion of pregnant animals (64.3%) was greater in adult ewes that received eCG at the time of device removal than that in ewe lambs (39.7%). In their study (Martinez *et al.,* 2015), mature ewes were almost three times more likely to carry a twin pregnancy than ewe lambs, and ewes that received eCG at the time of device removal were more likely to carry twins than those not received eCG. In contrast, in a previous study, administration of eCG 1 day before sponge removal which was in place for 12 days had no effect on TR of cyclic ewes fed with a high energy diet for a short period (Habibizad *et al.,* 2015). In the present experiment, only nulliparous ewe lambs were used and all ewe lambs received an intravaginal P_4-releasing device for 14 days. Although CR (90.0%) and PR (70.0%) at days 20 and 35, respectively, in the ewe lambs that received GnRH at the time of device insertion and eCG and PGF2α at the time of device withdrawal early in the breeding season were greater than those in all other groups that did not receive eCG at CIDR withdrawal, the difference was not significant. These results are in consistent with those of D'Souza *et al*. (2014) who demonstrated that CR and PR of ewes treated with a mixture of eCG and hCG at the time of CIDR removal which was in place for 5 days during anoestrus period were only numerically greater than those observed in control ewes.

In the present study, only one of the ewe lambs in P_4eCG group that received eCG at CIDR withdrawal had twin birth. In contrast to this finding, some previous studies reported that administering eCG to low prolific sheep breeds can enhance TR (Boscos *et al.,* 2002; Ali, 2007). The discrepancy between the present study and those of the previous studies may be the fact that in addition to administering eCG, incidence of twinning correlates with other factors such as breed, nutrition, and the dam age at breeding, and increases as the age of the dam increases. Sanjabee ewe lambs used in the current study have been considered as low-prolific sheep. Moreover, the animals were nulliparous and aged between 8 and 9 months.

Interestingly, the ewe lambs in P_4PG group that neither received GnRH nor gonadotropins and only received PGF2α at CIDR removal were better in some reproductive performance variations such as CR, PR, LR, and FR compared to both P_4GnRH group that received GnRH at the time of CIDR insertion and PGF2α at the time of CIDR removal, and P_4hCG group that received GnRH at the time of CIDR insertion, and PGF2α and hCG at the time of CIDR removal. On the other hand, the results showed that administration of hCG at CIDR removal caused no significant improvement in the reproductive performance variables compared to those that did not receive hCG, which is consistent with the results of Cabrera *et al*. (2019) who reported that administration of gonadotropins at the time of CIDR removal that was in place for 5 days had no effect on lambing rate of multiparous ewes during the transition period. In a recent study (Dias *et al.,* 2020), CR in ewe lambs that were administered an intravaginal device containing medroxyprogesterone acetate for 12 days, with or without eCG or eCG and hCG at the time of device removal, was only greater in the eCG group. Similar to Dias *et al*. (2020), Santos *et al*. (2010) demonstrated greater PRs in artificially inseminated ewes after eCG treatment than treatment with eCG and hCG. In contrast, it has been reported that administering a combination of eCG and hCG treatment to doe goats resulted in a greater PR compared to treatment with eCG alone (Rowe and East, 1996). Gómez-Brunet *et al*. (2007) reported improved reproductive responses after administration of hCG at the time of artificial insemination in a P_4/eCG treatment regimen, only at farms where reproductive rates were sub-optimal. In a study by Cueto *et al*. (2020), it was demonstrated that the fecundity rate in Merino ewes and ewe lambs that received eCG at the end of synchronization programs with or without inserting intravaginal P_4 releasing device was greater than that in those that did not receive eCG during the breeding season. However, earlier studies have reported either no effect (Knights *et al.,* 2003) or decreased (Evans and Armstrong, 1984) CR, PR and LR following administration of eCG. Variability between results could be attributed to different protocols, management systems, nutritional status or physiological status resulting from diverse experimental conditions (Fernandez *et al.,* 2019).

The results of the current study demonstrated that administering eCG or hCG at the end of a 14-day P_4-based synchronization program early in the breeding season resulted in no significant improvement in reproductive performance of Sanjabee ewe lambs compared to those not received eCG or hCG. In addition, administering GnRH at the device insertion did not improve reproductive performance of ewe lambs significantly compared to those not received GnRH. Overall, according to the results of the current study inserting a CIDR device for 14 days combined with (high cost) or without (low cost) administration of GnRH at the device insertion, and PGF2α or gonadotropins (eCG or hCG) at the device removal early in the breeding season has comparable effect on the reproductive performance of Sanjabee ewe lambs. Since a major limitation of the present study was the small number of the animals used, conducting the experiment on a larger number of animals may provide more precise results, therefore, more precise recommendations for sheep farmers.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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