



THE EFFECT OF PROGESTIN SOURCE ON SOME REPRODUCTIVE PERFORMANCE IN AKKARAMAN EWES

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Abstract: This study was conducted to determine the effect of progestin source on some reproductive performance, lamb birth weight and lamb mortality rate in Akkaraman ewes. A total of 40 Akkaraman sheep breed with similar body weight (51.3 ± 1.5 kg) and at least two parturitions were used as experimental animals. In all ewes, the intramuscular injection of PGF_{2α} (2.5 mg) was administered 96 hours before estrus synchronization to obtain corpus luteum regression. The ewes were allocated randomly into two groups according to body weight and ages. Estrus of ewes in the first group (n=20) were synchronized with an intra-vaginal CIDR device containing 0.30 g of natural progesterone. Estrus of ewes in the second group (n=20) were synchronized with an intra-vaginal sponge containing 30 mg flugestone acetate (FGA). CIDR and sponge were withdrawn following 12 days and 600 IU PMSG were injected intramuscularly. After 24 hours from injections, all ewes were introduced to Akkaraman rams and ewes in estrus were recorded. There were no significant differences between natural and synthetic progesterone applications in terms of estrus rate, gestation rate and duration of gestation in Akkaraman ewes. Additionally, lamb birth weight and lamb mortality rates were similar in both experimental groups. However, the application of CIDR increased the total and multiple lamb birth rates of Akkaraman ewes ($P < 0.05$). These results show that the application of CIDR device with PMSG may increase the success rate in lamb production in Akkaraman ewes.


Keywords: Estrus synchronization, Natural progesterone, Flugestone acetate, Lamb production, Akkaraman

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1. Introduction

Reproduction is the physiological basis of all animal production (Jainudeen and Hafez, 1987). The reproductive performance of sheep is essential for productivity in lamb production (Jainudeen and Hafez, 1987). To realize the reproductive potential of sheep at an optimal level; is based on the improvement of fertility, which can be listed as increasing the number of lambing per unit time, increasing twinning, and reaching two lambing per year or three lambing in two years (Elinç et al., 1986). Reproduction in animal husbandry directly determines the economic level of production, as it provides the continuation of the species and is the source of various yields (Aşkın, 1982; Aksoy et al., 2018; Aksoy et al., 2019; Kızılaslan et al., 2021). For these reasons, it is essential to control the reproduction processes to increase reproductive performance.

Although obtaining semen from selected male animals in livestock and keeping it for a long time allows controlled breeding to a large extent, methods that will detect estrus provide a tremendous advantage for the effective and timely use of artificial insemination (Kaymakçı, 2006). Considering the growing dimensions of animal production, almost no approach to standard breeding methods includes an understanding that will allow insemination at the optimum time for reproduction. In

this case, the control of the estrus cycle using exogenous hormones and thus the estimation of the time when the animals' estrus starts to appear is a more logical and satisfying method (Wheaton et al., 1993; Moeini et al. 2007).

In traditional sheep breeding, rams together with the sheep throughout the year, and the physiological stages of sheep may occur in a wide variety in mating season (Sen et al., 2016). Some animals may exhibit estrus, some dry, and some may be in late gestation or lactation. Due to these different physiological structures, the needs of the sheep also differ. Therefore, it is very difficult to synchronization of estrus or births in traditional sheep breeding. This situation causes the irregular use of resources in the enterprise and may adversely affect the economic profit and level (Edea et al., 2012). With exogenous hormone applications, it is possible to collect the animals' estrus, create simultaneous births, and lamb outside the breeding season (Wheaton et al., 1993). Many estrus synchronization methods are applied in sheep, and the most commonly used protocols are progesterone-based ones (Şen and Onder, 2016; Gül and Keskin, 2010). The success rate of estrus synchronization in sheep is affected by many factors such as the hormone used in the applications, the dose of the hormone, the application time, animal age, breed, and breeding season



(Hashemi et al., 2005; Gül et al., 2020). The main reason is that the individual responses of ewes to estrus synchronization applications are different. In general, synthetic precursor hormones are used in estrus synchronization in sheep, and the effects of these hormones may differ (Kutluca, 2009; Gül and Erdoğan, 2021). Therefore, it is crucial to determine the response of ewes to applications containing natural hormones to assess the effects of estrus synchronization applications on reproductive performance.

In the last 30 years, many studies have been conducted to determine the effects of estrus synchronization applications on the reproductive performance characteristics of sheep. Akkaraman sheep breed is widely raised in the Middle Anatolian region and is one of Türkiye's crucial domestic gene resources. However, there is a shortage of information on estrus synchronization efficiency and reproductive performance in this breed induced by hormonal treatments during the breeding season. Therefore, this study aims to determine the effects of natural and synthetic progesterone applications for estrus synchronization on some reproductive performance characteristics of Akkaraman ewes.

2. Materials and Methods

The study was conducted within sheep's normal seasonal breeding cycle in Türkiye (September to March). A total of 40 adult Akkaraman ewes, which had at least two parturitions, ranging from 2 to 3 years of age and similar body weight (51.3 ± 1.5 kg) were used as experimental material. In all ewes, the intramuscular injection of PGF_{2α} (2.5 mg) was administered 96 hours before estrus synchronization to obtain corpus luteum regression. Ewes were randomly divided into two equal groups considering their body weight and ages. The estrus of the ewes in the first group (body weight= 51.2 ± 1.4 ; n=20) was synchronized by using the CIDR vaginal implant device containing natural progesterone (0.30 g progesterone). The estrus of the ewes in the second group (body weight= 51.5 ± 1.7 ; n=20) were synchronized using an intravaginal sponge containing synthetic progesterone (30 mg flugestone acetate; FGA). The CIDRs

and sponge were left in the vagina for 12 days. Following the withdrawal of the CIDR or sponge, 600 IU pregnant mare serum (PMSG) was injected intramuscularly simultaneously. The ewes were introduced to the Akkaraman ram 48 hours after the injection by group mating, and ewes that showed estrus and mated were recorded during two weeks. The ewes that did not exhibit estrus and did not mate were excluded from the experiment.

The estrus rates of ewes were calculated by the ratio of the number of ewes in estrus to the number of ewes in the experiment. Birth type (single or twin), sex and birth weight of lambs were determined within 12 hours after lambing. The gestation rate (the number of pregnant ewes/number of ewes in the experiment \times 100), gestation period, lambing rate (the number of lambs born / the number of ewes in the experiment \times 100), twin birth rate (the number of twins born / the number of ewes in the experiment \times 100), birth period (starting and ending of births) and the lamb mortality rate until weaning (the number of lambs died until weaning/number of lambs born \times 100) were also determined in both experimental groups (Tamer and Sirin, 2021).

2.1. Statistical Analysis

Data related to lamb birth weight, lambing period, and gestation period were analyzed using a completely randomized design by the General Linear Model procedure of the SPSS package program. Duncan's test showed significant differences between means, and results were computed as mean \pm SE. Statistical significance was considered at $P < 0.05$. CIDR or sponge drop rate, estrus rate, gestation rate, lambing rate, twin birth rate, and singleton birth rate were analyzed by chi-square (χ^2) test. Kruskal-Wallis H test was performed to analyze the effect of lamb birth weight on survival status until weaning.

3. Results

Some reproductive characteristics of Akkaraman ewes, which are synchronized with CIDR or sponge applications, are presented in Table 1.

Table 1. Some reproductive characteristics of Akkaraman ewes, which are synchronized with CIDR or sponge applications

Traits (%)	CIDR (n=20)	Sponge (n=20)
Lost rate*	0/20 (0.0)	2/20 (10.0)
Estrus rate	16/20 (80.0)	15/20 (75.0)
Gestation rate	15/16 (94.0)	14/15 (93.0)
Lambing rate*	22/20 (110.0) ^a	16/18 (89.0) ^b
Twin lambing rate*	7/15 (47.0) ^a	2/14 (14.3) ^b
Singleton lambing rate*	8/15 (53.0) ^b	12/14 (86.0) ^a
Lamb mortality rate	3/22 (14.0)	2/16 (13.0)

*Means in rows are significantly different at $P < 0.05$.

In the current study, during the estrus synchronization application (12 days), the CIDR device never fell, while sponge lost was observed in 10% of the ewes that were treated with synthetic progesterone sponge ($P<0.05$). While no difference was observed between the experimental groups in terms of the estrus and gestation rates, it was determined that the rate of total (110.0% and 89.0%) and twin lambing (47.0% and 14.3%) in sheep treated with CIDR were higher than in sheep treated with the sponge ($P<0.05$). In addition, the rate of singletons (53.0% and 86.0%) was found to be lower in sheep treated with CIDR than in sheep treated with the

sponge ($P<0.05$). There were no significant differences in terms of the lambs' mortality rate until the weaning age between experimental groups.

Lambing interval and gestation period of Akkaraman ewes, which is synchronized with CIDR or sponge applications, are presented in Figures 1 and 2, respectively. In the present study, no difference was found between the CIDR and sponge applications groups regarding lambing interval (CIDR; 18 days and sponge; 20 days) and gestation period (CIDR; 146 sponge; 149 days).

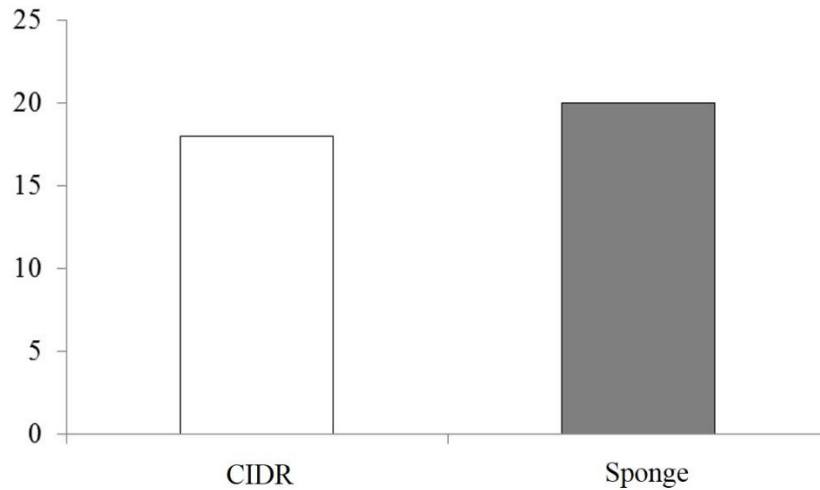


Figure 1. Lambing interval of Akkaraman ewes, which is synchronized with CIDR or sponge applications.

Lamb birth weights of Akkaraman ewes, which is synchronized with CIDR or sponge applications, are presented in Figure 3. There were no significant differences in terms of lamb birth weights between the

experimental groups. The mean lamb birth weight in the CIDR treated group was 4.8 ± 0.14 kg, and the average lamb birth weight in the sponge treated group was 4.6 ± 0.13 kg.

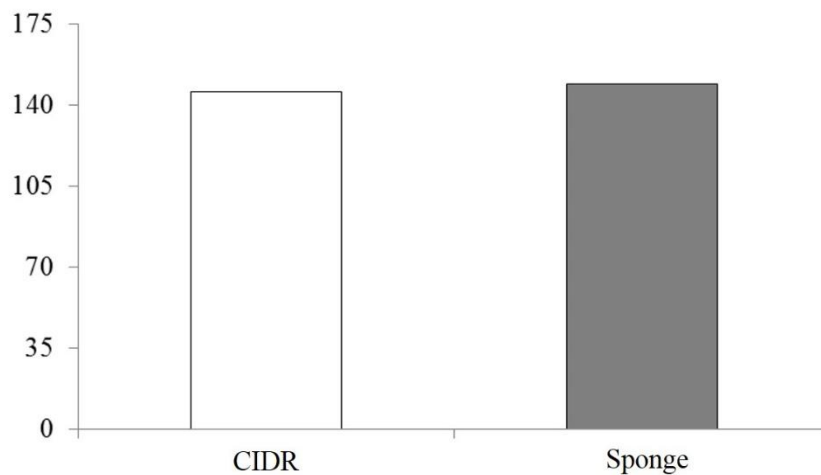


Figure 2. Gestation period of Akkaraman ewes, which is synchronized with CIDR or sponge applications.

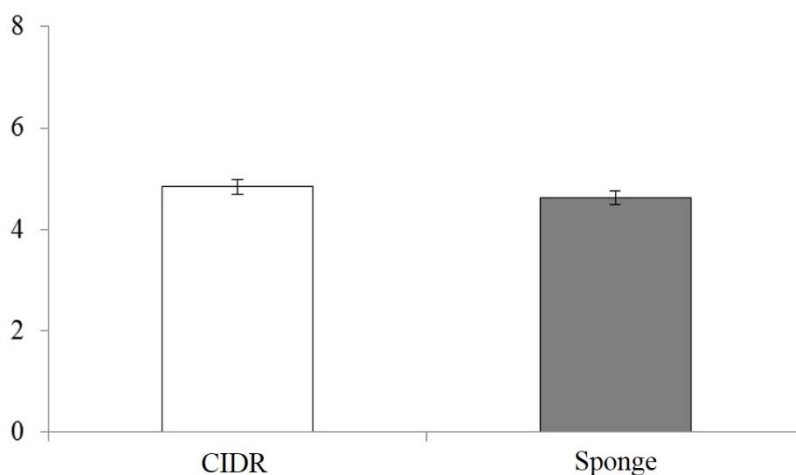


Figure 3. Lamb birth weights of Akkaraman ewes, which is synchronized with CIDR or sponge applications.

4. Discussion

In the current study, it was observed that the use of a CIDR device containing natural progesterone in estrus synchronization increased the total lambing rate and twinning rate compared to the intravaginal sponge containing synthetic progesterone. There was no difference between the treatments in terms of estrus rate, gestation rate, lamb birth weight and the lamb mortality rate weaning age.

In the previous studies with the use of CIDR and sponge in sheep, techniques employed in inserting and factors such as texture and consistency could influence CIDR or sponge retention in the vagina (Alifakiotist et al., 1982; Romano, 1996). Aşkın (1982) reported that intravaginal sponge loss was 6.34% in Anatolian Merinos ewes and 1.32% in Akkaraman ewes. On the contrary, Moeini et al. (2007) and Romano (1996) reported that no CIDR or intravaginal sponge were lost during estrus synchronization period. Previous studies reported that a higher number of CIDR drop in ewes (Welch et al., 1984; Rhodes and Nathanielsz, 1988). There was no loss during the synchronization period in the CIDR in the current study, while experienced a 10% loss in the intravaginal sponge. Although this result is higher than previous studies results, this difference may be due to breed or the number of ewes used in the experiments.

Başaran and Dellal (1997) reported that the application of synthetic progesterone (40 mg FGA) impregnated sponge and PMSG (500 I.U.) provided 97% of estrus in Akkaraman sheep. Aşkın (1982) reported the application of synthetic progesterone and different doses of PMSG in Anatolian Merino and Akkaraman ewes' estrus synchronization at rates of 98.12% and 97.89%, respectively. Karakuş and Aşkın (2007) investigated the effect of estrus synchronization with synthetic progesterone (40 mg FGA) impregnated sponges on fertility in Anatolian Merino and Malya sheep breeds and they were observed 100% estrus after synchronization in both breeds. In the current study, estrus was induced in 80.0% and 77.3% of the Akkaraman ewes treated with

CIDR and sponge, respectively. This result indicated that natural and synthetic progesterone application and fixed-dose PMSG applications did not affect the rate of estrus in the synchronization of estrus in Akkaraman ewes. In previous studies during breeding or out of breeding season similar results observed (Hashemi et al., 2006; Moeini et al., 2007). The current study results were lower than the studies of Başaran and Dellal (1997) and Aşkın (1982) in the same breed. This difference may be due to the number of animals used in the experiments or the regional conditions.

Although many factors such as type of intravaginal device, hormone dose, breed, age and season affect the fertility of sheep with synchronized estrus (Wheaton et al., 1993). The current study observed that natural and synthetic progesterone and fixed-dose PMSG applications did not affect the gestation rate in the synchronization of estrus in Akkaraman sheep. This agrees with results of previous studies (Luther et al., 2006; Moeini et al. 2007). Yaralı and Karaca (2004) reported that the average gestation rate was 59% as a result of using different PMSG doses together with synthetic progesterone sponge in estrus synchronization of Kıvrıkcık ewes. Bekyürek (1994) showed using the sponge containing 60 mg MAP and 500 I.U. PMSG injection caused a 70% gestation rate. Kaçar et al. (2008) reported a 50% gestation rate in Tuj sheep due to vaginal sponge application (containing 40 mg cronolone) and 600 I.U. PMSG injections. Smith (1988) determined the gestation rates in sheep whose estrus was synchronized using CIDR and PMSG, covering different seasons, as 94% for the winter period, 24% for the spring period, and 11% for the summer, and 63% for the autumn period. The present study results were higher than the studies mentioned above. These differences may be due to the animal breed used, the different physiological responses of the breeds to the treatments, or the breeding season.

Total lambing rate in sheep flocks is one of the most important indicators of farming profitability. Moreover, the total lambing rate following estrus synchronization applications shows successful degree of the applications.

Previous studies showed that different sources of progesterone application (MAP; 45.0%, fluorogestone acetate; 41.5%, CIDR; 57.9%, and progesterone sponge; 39.5%) to estrus synchronization influence lambing rate (Fukui et al., 1999). Aşkın (1982) reported that intravaginal sponge containing synthetic progesterone (40 mg FGA) and 200, 400, and 600 I.U. of PMSG applications caused 150.76%, 178.57%, and 197.14% in Anatolian Merinos ewes, and 135.71%, 178.26%, and 170.83% in Akkaramans ewes a total lambing rate, respectively. Ozcan et al. (1994), reported that sponge (containing 40 mg chronolone) and 500 I.U. PMSG application caused 51.1% lambing. Başaran and Dellal (1997) reported that the lambing rate was 170.0% after the application of sponge (40 mg FGA) and PMSG (500 I.U.) in Akkaraman sheep. Koyuncu et al. (2001) reported the lambing rate as 94.87% and 96.66%, respectively, after applying an intravaginal sponge (containing 40 mg FGA) 500 or 700 I.U. PMSG in Kıvrıkcık sheep. Daşkın (2001) reported that applying synthetic progesterone (30 mg FGA) and 500 mg PMSG during the breeding season in Akkaraman sheep caused 92.30% lambing. Kutluca (2009), at the end of the mating season in Morkaraman sheep, as a result of natural and synthetic progesterone (CIDR, Crestar, Natural progesterone, Cronolone, and MAP) applications, lambing rates were determined by CIDR; 74%, Cronolone; 61%, natural progesterone; 56%, MAP; 33% and 10% for crestar. It should be pointed out that in various studies, reproductive parameters may be calculated differently which should be taken into consideration when results are compared. For example, the number of lambs born per ewe lambled and the number of lambs born per ewe in estrus were accounted for in calculating fecundity and prolificacy, respectively. In the current study, PMSG injection and natural progesterone application were more successful than synthetic progesterone application in terms of lambing rate in synchronization of estrus in Akkaraman sheep. The present study results are in agreement with the studies mentioned above.

PMSG is widely used to increase ovarian activity and litter size in progesterone-based estrus synchronizations in small ruminants. However, in estrus synchronization applications, progesterone source can be effective on PMSG activity or multiple births (Wheaton et al., 1993; Romano, 1996; Moeini et al. 2007). Aşkın (1982) reported that sponges (containing 40 mg FGA) and different doses of PMSG caused 52.3% singleton, 44.62% twin, and 3.08% triplets in 200 I.U. PMSG, 27.14% singleton, 68.57% twin; 2.86% triplets and 1.43% quadruplets in 400 I.U. PMSG, 15.71% singleton, 71.43% twins and 12.86% triplets in 400 I.U. PMSG were born in Anatolian Merinos. The same author observed that sponge (containing 40 mg FGA) and different doses of PMSG caused 94.29% singleton and 5.71% twin in 200 I.U. PMSG, 30.43% singleton, 60.87% twin, and 8.70% triplet in 600 I.U. PMSG, 33.33% singleton, 62.50% twin, and 4.17% triplet in 80 I.U. PMSG application. Ozcan et al.

(1994) reported that sponge (containing 40 mg chronolone) and 500 I.U. PMSG application caused 61.7% twins, 6.4% triplets, and 0.5% singletons in the Awassi sheep breed. Daşkın (2001) observed that sponge (30 mg FGA) and 500 I.U. PMSG application caused 58.34% singleton and 41.66% twins born in Akkaraman ewes. Karakuş and Aşkın (2007) reported that sponge (40 mg FGA) application caused 56.14% singleton, 36.84% twin, and 7.02% triplet birth in Anatolian Merino ewes, and also 54.84% single, 35.48% twin and 9.68% triplet birth in Malya ewes. The current study observed that PMSG injection and natural progesterone application in the synchronization of estrus in Akkaraman sheep causes twinning at a higher rate than PMSG injection together with synthetic progesterone application. The present study results are in agreement with some of the studies, but different from some of the studies. These differences may be caused by the breed, the different physiological responses of the breeds to the treatments, the breeding season, or the nutritional conditions.

Previous studies indicated that different sources of progesterone application (CIDR; 10.5%, cronolone; 7.9 %, and natural progesterone; 11.6%) to estrus synchronization did not influence lamb's mortality rate until weaning (Kutluca, 2009). Berhan and Van Arendonk (2006) reported breed affected the lamb mortality rate until weaning following in the vaginal sponge (containing 40 mg of FGA) application (Horro breed 13% and Menz breed 27%). Basaran et al. (1996) reported that the lamb mortality rate until weaning in the vaginal sponge (containing 40 mg of FGA) treated France x Akkaraman crosses was 17.65% and 7.14%, respectively, and the lamb mortality rate in Border Leicester x Akkaraman crosses 6.67% and 5.88%, respectively. In the current study, CDIR and sponge application and fixed-dose PMSG applications did not affect the lamb mortality rate until weaning in Akkaraman sheep. The present study results are in agreement with the studies mentioned above.

Godfrey et al. (1997) reported that CIDR applied St. Croix White, Barbados Blackbelly, and Florida ewes had a shorter gestation period than the ewes in the control group. Ülker et al. (2004) reported that sponge (containing 40 mg medroxyprogesterone acetate; MAP) and 600 I.U. PMSG application did not affect the gestation duration between Karakaş and Norduz sheep breeds. Zarkawi (2001) reported that sponge (containing 40 MAP) and 600 I.U. PMSG applied Awassi sheep had 150.7 days of gestation duration, but control ewes had 52.5 days. Timurkan (2005) reported that the gestation duration in estrus synchronized Hamdani ewes with the sponge containing 40 mg FGA and 500 IU PMSG and non-synchronized ewes was 152 and 160 days, respectively. In the current study, CDIR and sponge application and fixed-dose PMSG applications did not affect the gestation duration of Akkaraman sheep. The present study results are mainly similar to the studies mentioned above.

Aşkın (1982) reported intravaginal sponge (containing 40 mg FGA) and PMSG application caused 91.08% of

Anatolian Merinos and 92.37% of Akkaraman sheep to give birth within one week. Başaran (1995) reported that lambing was completed by 92.08% within nine days in Awassi ewes, which were applied intravaginal sponge (containing 60 mg MAP) and PMSG, and by 97.45% within 30 days in the control group. Similarly, Başaran and Dellal (1997) reported that the lambing was completed within ten days in Akkaraman ewes treated with progesterone and PMSG while finished in 45 days in the control group. In the current study, CIDR and sponge application and fixed-dose PMSG applications did not affect lambing duration in Akkaraman ewes. The present study results were higher than the studies mentioned above, and these differences may be due to the animal breed used, the different physiological responses of the breeds to the treatments, or the breeding season.

Kutluca (2009) reported that lambs' birth weight wasn't affected by the applications of natural and synthetic progesterone (CIDR; 4.84 kg, cronolone; 4.96 kg and natural progesterone; 5.25 kg) for estrus synchronization in Morkaraman sheep breed at the end of the breeding season. Moreover, Kutluca (2005) reported the birth weights of lambs born from Awassi and Morkaraman ewes, treated with sponges containing synthetic progesterone, as 3.2 and 4.20 kg, respectively. Ülker et al. (2004) determined that lamb birth weights were 4.61 kg in Karakaş and Norduz sheep, resulting from sponge application (containing 40 mg MAP) for estrus synchronizing. In the current study, it was observed that natural and synthetic progesterone application and fixed-dose PMSG applications did not affect the live weights of the lambs born in the synchronization of the estrus of Akkaraman sheep. The present study results are mainly similar to the studies mentioned above.

5. Conclusion

As a result, it has been revealed that CIDR (natural) and sponge (synthetic) sourced progesterone application can be used in combination with PMSG for estrus synchronization in Akkaraman ewes, but the application of CIDR device containing natural progesterone together with PMSG increases the success in twin rate. In addition, the absence of losses in the CIDR device containing natural progesterone during the application makes this application more preferable in Akkaraman sheep breed.

Author Contributions

D.G. (25%), B.B. (25%) and U.Ş. (50%) design of study. D.G. (25%), B.B. (25%) and U.Ş. (50%) data acquisition and analysis. D.G. (25%), B.B. (25%) and U.Ş. (50%) writing up. D.G. (50%), B.B. (25%) and U.Ş. (25%) submission and revision. All authors reviewed and approved final version of the manuscript.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

The authors confirm that the ethical policies of the journal, as noted on the journal's author guidelines page, have been adhered to. The experimental procedures were approved by the Local Animal Care and Ethics Committee of Ahi Evran University, Kirsehir, Türkiye, ensuring compliance with directive 86/609/EEC for animal experiments (Date: February 23, 2016, Approve number: 2016/4).

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