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Effects of Melatonin and Vaginal Sponges Plus eCG on Reproductive Performance in Iraqi Goat

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Abstract

Background: Reproductive management in goats is essential for optimizing productivity and enhancing breeding efficiency, especially in regions with high demand for livestock products. Hormonal treatments, such as subcutaneous melatonin implants and intra-vaginal sponges combined with equine chorionic gonadotropin (eCG), have been widely studied for their potential to improve estrus synchronization and fertility outcomes in small ruminants. **Aim:** This study aimed to evaluate the efficacy of these treatments on the reproductive performance of Iraqi goats. **Methods:** The experiment involved 21 goats, aged 8–10 months, and three fertile bucks. The goats were randomly allocated into three groups. Group 1 received melatonin implants subcutaneously for 30 days, Group 2 was treated with intra-vaginal sponges for 12 days followed by an eCG injection at sponge removal, and Group 3 served as the untreated control. **Results:** The results indicated that G2 exhibited a significantly higher ($P \leq 0.05$) estrus response and estrus duration compared to G1 and G3. Moreover, G2 recorded the longest ($P < 0.01$) estrous phase, while G1 showed intermediate values, and G3 had the shortest. Conception rates were significantly higher ($P \leq 0.05$) in G2 compared to the other groups. Male offspring were more prevalent ($P \leq 0.05$) than female offspring across all groups, with no significant differences observed in viability rates or the nature of parturition. In terms of hormonal analysis, no significant differences were detected in serum progesterone concentrations at Day 0. However, during the estrus and luteal phases, G3 exhibited higher progesterone levels compared to G1 and G2. Serum IGF-1 levels were significantly higher ($P \leq 0.05$) in G2 during the estrus phase compared to G3, with no significant differences observed during the luteal phase. **Conclusion:** In conclusion, intra-vaginal sponges combined with eCG are highly effective for improving estrus induction, pregnancy rates, and reproductive performance in Iraqi goats, providing a practical and cost-effective solution for livestock breeders.

Key words: Melatonin, eCG, Pregnancy, Progesterone, Vaginal Sponges.
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Introduction

Goats are seasonal polyestrous animals, with their reproductive cycles strongly influenced by daylight length. The onset and duration of the breeding season depend on several factors, including both genetic and non-genetic aspects (1). Livestock production plays a significant role in economic development, particularly by supporting subsistence farming and providing high-value protein to low-income populations (2). In goats, the breeding season typically begins in the fall and continues through mid to late winter, while the anestrous period occurs during spring and summer (3,4). The timing and duration of the breeding season are influenced by the interaction between genetic traits and environmental factors, particularly photoperiod (5,6). Estrus synchronization is one of the key reproductive technologies used to enhance fertility in goats. It involves modifying the luteal phase of the estrous cycle through artificial prolongation, creating a synthetic luteal phase, or regulating the follicular phase (7). In ewes, synchronization can be achieved by administering external hormones such as progestins (8) and equine chorionic gonadotropin (eCG) (9,10,8). The combination of eCG with progesterone improves estrus response and gestation rates during both breeding and non-breeding seasons (9). In sheep and goats, estrus synchronization can also be accomplished through various techniques, including the male effect, daylight manipulation, and hormonal treatments

such as progesterone, eCG, prostaglandins, melatonin, kisspeptin, and bromocriptine (10,11,12,13,14,15,16). Intravaginal sponges containing synthetic progesterone and pregnant mare serum gonadotropin (PMSG) are commonly used to induce estrus and superovulation in goats (17). PMSG has been reported to increase conception and twinning rates, particularly in breeds with small litter sizes (18). for producers, estrus synchronization and hormonal induction outside the reproductive season offer significant commercial and management advantages (19). Progesterone, produced by the corpus luteum, is essential for maintaining pregnancy during the gestational phase (20). During the non-breeding season, medroxyprogesterone acetate (MPA)-impregnated sponges combined with 500 IU eCG have been shown to effectively induce estrus in female goats (21). Melatonin, a natural hormone present in all domestic animals, plays a crucial role in linking photoperiod signals to the reproductive neuro-endocrine axis. It is synthesized by the pineal gland from tryptophan and serotonin and influences the hypothalamus to release gonadotropin-releasing hormone (GnRH) (22). Studies have highlighted the significant impact of melatonin implants in improving reproductive performance, including enhanced lambing and twinning rates, reduced days open, and improved overall reproductive parameters in goats and sheep (11,23). The combination of melatonin or vaginal sponges with equine chorionic gonadotropin (eCG) has also been shown to be effective in improving fertility, reducing days open, increasing pregnancy rates, and boosting twinning rates (11). One of the key indicators of reproductive status in animals is the measurement of progesterone levels during different physiological phases, as it provides valuable insights into reproductive health and functionality (24). Monitoring progesterone levels in goats is recommended between days 21 and 24 after breeding to assess reproductive health. A proper balance between hormone concentrations, particularly a decrease in progesterone and a corresponding increase in estrogen, is critical for cervical dilation. Disruptions in this hormonal balance can result in dystocia, leading to significant economic losses (25). In Iraqi goats, the concentrations of estrogen and progesterone have been associated with follicle size (26). Progesterone levels in estrous does are typically very low but begin to rise on day 6 of the cycle, peak around day 12, and drop sharply by day 15 in non-pregnant does. However, in pregnant does, progesterone levels remain elevated, supporting pregnancy maintenance (27). Insulin-like growth factor-I (IGF-I) plays a vital role in various physiological processes, particularly in reproduction and lactation (28,29,30). IGF-I mediates the anti-apoptotic effects of follicle-stimulating hormone (FSH) on granulosa cells in medium-sized follicles, contributing to the survival and proliferation of oocytes (31,32). It is also essential for follicular growth (33) and enhances the survival of spermatozoa and embryos (34). Studies have shown elevated plasma IGF-I levels during the estrus cycle in both sheep (35,36) and Shiba goats (37). This highlights the significant role of the IGF-I system in regulating follicular development, as further supported by findings from (34,39,40,41). Although ovarian follicles are known to respond to IGF-I, its specific role in the development of goat preantral follicles remains poorly understood (42). Plasma IGF-I concentrations increase during estrus in ruminants (37), but the exact origin of circulating IGF-I is still unclear. Research suggests that IGF-I is synthesized in reproductive organs, including the ovary (43), oviduct (44), and uterus (45), in non-pregnant animals. The uterus, in particular, is hypothesized to be a primary source of IGF-I during estrus. Supporting evidence includes observations that IGF-I mRNA levels peak in the

endometrium and myometrium of the ovine uterus during estrus (44), IGF-I is secreted into the uterine lumen in sheep and cows around estrus (46), and estrogens are known to increase IGF-I mRNA levels in the uterus (44). This study aims to explore the effectiveness of subcutaneous implants of melatonin and intravaginal sponges, along with eCG, in enhancing reproductive performance, as there is limited information on insulin-like growth factor 1 profile and progesterone levels during physiological states.

Materials and Methods

Ethical Approval

Before any experiment performing, the experimental protocol and design used in present study were examined and approved by the Committee of Ethics in College of Veterinary Medicine, University of Baghdad, Baghdad, Iraq (Number P. G/2002 at 20/10 2024).

Experimental animals

The research was done at a specific area identified Al-Asimah Station, which is located 25 kilometers northwest of Baghdad, specifically in Khan Dhari. The local goat herd consisted of twenty-one juvenile goats, aged between 8 and 10 months, with an average weight ranging from 20 to 25 kg. In addition, there were three sexually mature (bucks) male goats, aged between 1 and 1.5 years of age, which were confirmed via physical examination of their bodily and laboratory examination for Semen fluid, has been utilized for the purpose of detecting estrus and facilitating mating. Prior to assessment, the animals were prepped by fasting for twelve hours to increase the accuracy of transrectal and transabdominal scanning and vaginal inspection by speculum to ensure that the females were not pregnant and free of any deformities or infections (47). stated that in order to obtain a high-quality picture, the doe should be examined in an area with little light and away from the sun. Trans abdominal transducers take an average of 2.5 minutes, while trans rectal transducers take an average of 1.5 minutes (7). They were provided with shelter in a somewhat shaded area in relation to their food. All the animals enrolled in this study was immunized against enterotoxaemia as well as intervention therapy for external and internal parasites such as Rafoxanide and Ivermectin.

Experimental design

Goats were divided into three groups at random (seven goat each), group 1, 2 and 3, group 1 was received ear implants melatonin hormone providing 18 mg for a duration of thirty days. group 2 was received vaginal sponge for 12 days with i/m injection 500 IU of eCG at withdrawal of the sponges. group 3 was not treated and served as control group. The animals were housed in a semi-open shade shelter, supplied with ad libitum access to drinking water and a concentrated meal of 1 kg. A balanced grain diet consists of 40% barley, 51% wheat, 5% soybean, 2% limestone, 1% sodium chloride, and 1% vitamins and minerals. The research study was extended from November of 2023 to May of 2024.

Clinical study

Non-pregnancy verification was conducted using ultrasonography, while estrus detection was performed with an aproned buck throughout two consecutive cycles to monitor estrus activity in experimental animals. Estrus synchronization involved ear implants of melatonin hormone at a dosage of 18 mg for 30 days, along with vaginal sponges for 12 days. After sponge removal, an intramuscular injection of 500 IU eCG was administered (48). Estrus detection was conducted to assess the estrus response, the percentage of responsive animals, and the duration of the estrus phase. Responsive animals were mated with a fertile buck, and pregnancy was confirmed via ultrasonography, followed by monitoring until parturition. Prior to the use of melatonin implants and vaginal sponges, all goats were exposed to three

fertile aproned bucks (49) for 2 hours in the morning and 2 hours in the evening daily, for two successive cycles from November to mid-December.

Assessment of Hormones assay

Blood samples were drawn from the does' jugular vein and evacuated into Gel tubes on the day -0 before to mating, throughout estrus phase, luteal phase and monthly after treatment to determine P4 and IGF-1, Serum was collected after centrifugation with 3000 rpm for 10 minutes and stored by Eppendorf tube at -20ºC until assays of hormonal concentrations (50,51). using particular P4 and IGF-1 ELISA kit techniques idle (China) for goats.

Statistical Analysis

The SAS Statistical Analysis System (2018) software was utilized to ascertain the impact of distinct groups on the study parameters. To compare means significantly, the least significant difference, or LSD, was employed. In this study, the chi-square test was utilized to compression the percentage (0.05 and 0.01) likelihood in a meaningful way (52,1).

Results

Estrus response and duration response in goats

The results in the current study revealed that goats in G1 5 (71.43%), G2 7 (100 %) and G3 3 (28.57%) After estrous induction regimens, displayed estrous indications. Group two showed a greater significant value (P≤0.05) than both groups one and three, whereas group one showed a considerably higher value (P≤0.05) than group three. The percentage of non-estrous goats were in group two 0 (00.00%) demonstrated considerably (P≤0.05) less comparing to group one 2 (28.57%) and group three 5 (71.43%). The duration of estrous phase/ hours in group two (36.98 ±0.81) appeared considerably (P≤0.01) greater compared to group three (29.88 ±1.34) and group one (27.81 ±1.32). this shown in table 1 and figure 1.

Effects of melatonin and vaginal sponges on pregnancy rates in goats

The present study demonstrated that the number of pregnancy goats in group two 6 (85.71%) seemed considerably (P≤0.01) bigger compared to group one 3 (42.86%) and group three Control (00.00%), whereas in group one 3 (42.86%) showed significantly (P≤0.01) higher when compression with group three 3 (00.00%). In total single and multiple pregnancy rate where 7 (77.78%) and 2 (22.22%), correspondingly. In conceptions rates, goats in group two 6 (85.71%) showed significantly (P≤0.01) much higher compared to group one 3 (42.86%) and group three 0 (0%), whereas in group one 3 (42.86%) showed significantly (P≤0.01) higher compared to control group (3) 0 (0%), this shown in table 2 and figure 2.

Nature of parturition, Viability rate, kidding rate and sex of offspring

The findings demonstrated a statistically significant distinction (P≤0.05) in the overall sex ratio of the offspring where male kids elevated substantially 7 (63.64%) when comparing to female kids 4 (36.36%). The number of kids in group one, two, and three were (3, 8 and 0), respectively. The percentage of the Alive kids was 100% (11/11), therefore there was no significant difference in the viability rate across each group. The overall proportion for normal births was 100% (11/11), there was also no significant difference in the nature of parturition among all groups, result showed in table 3.

Progesterone and Serum Insulin like growth factor concentrations ng/ml at different periods.

The recent study outcome that revealed serum progesterone concentration at Day-0 there were no significant differences between all groups. At estrus phase, group three (1.58) demonstrated significant differences when compared to group one (0.949) and group two (0.551) at (P≤0.01). At luteal phase group two (6.47) demonstrated increasing significantly

(P≤0.01) with group three (1.93), while group one there was no significant differences compared to group three. The results of the current study revealed the serum IGF-1 levels at Day-0 there are no significant differences between all groups. At estrus phase in group two 95.04 was significantly (P≤0.01) raised when comparison to group three 59.08, whilst there were no significant distinctions when compared to group one 70.68. At luteal phase in group two that the level was 147.14 showed increasing significantly (P≤0.01) when comparison with group one and three were 96.77 and 54.05, respectively. result showed in table 5.

Ultrasonography images Show the genital reproductive in goats.

The result in (Fig 3) shows normal reproductive activity in a goat. Ovarian Follicles: If these structures are located in the ovarian region, they could represent developing follicles, suggesting the goat is in its estrous cycle. Ultrasound examination is a reliable method to assess ovarian activity or early pregnancy stages. Detection of follicles **.Ovarian Activity**: The labeled area shows smaller, fluid-filled structures representing ovarian follicles. This indicates that the goat is in an active reproductive phase. time ultrasonography allows identification of ovarian follicles, corpora lutea, and early gestational sacs with high accuracy. The urinary bladder often serves as a landmark during scans. (González-Bulnes et al., 2023). The result in (Fig 5) shows **Embryonic Vesicle:** The presence of an embryonic vesicle (a fluid-filled sac) is an early sign of pregnancy in goats. This sac contains the developing embryo and is typically visible around 18-25 days post-breeding. **Embryo:** The embryo is identified as a structure within the vesicle, confirming early pregnancy. In goats, the embryo becomes distinguishable by ultrasound after day 25 of gestation. **U.B (Urinary Bladder):** The urinary bladder (U.B) is a common structure visible in ultrasound and serves as a reference for orientation within the pelvic region. Interpretation: This image represents an early stage of pregnancy, likely around 25-35 days, where the embryonic vesicle and developing embryo are visualized. The result in (Fig 6) shows **Fetus:** A larger, more developed fetus is present, indicating a more advanced stage of gestation. The fetus becomes more distinct with increasing gestational age, and by 40-60 days, its features become identifiable. **Placentome:** Placentomes are attachments between the maternal uterine wall and the fetal membranes, responsible for nutrient exchange. In goats, they appear as circular to oval structures and are a hallmark of pregnancy after 30-35 days. or gestational sacs can be achieved by Day 20 post-breeding (98). The result in (Fig 4) shows annotated regions: U.B (Urinary Bladder) and Ovarian Activity. **Findings**:**U.B (Urinary Bladder)**: Seen as a large, fluid-filled area, often mistaken for a gestational sac but distinguished by its consistent position and shape

Interpretation: The presence of active follicles suggests that this goat is not pregnant but is preparing for ovulation. Real-

Interpretation: This image represents a later stage of pregnancy, likely beyond 45 days, with clear visualization of the fetus and placentomes. The size and development of these structures can help estimate gestational age. The result in (Fig 6) shows **Observations**: Two fetuses (**twin pregnancy**) are visible, indicating a multiple pregnancy around 60-65 days. A **placentome** is also present, reaffirming the pregnancy and proper maternal-fetal connections. **Interpretation**:Twin pregnancies in goats are common and considered a desirable outcome in many breeding programs. The presence of two fetuses with clear visualization supports normal development for this stage. The result in (Fig 7) shows **Observations**:Two fetuses (**twin pregnancy**) are visible, indicating a multiple pregnancy around 60-65 days. A **placentome** is also present, reaffirming the pregnancy and proper maternal-fetal connections. **Interpretation**:Twin pregnancies in goats are common and considered a desirable outcome in many breeding programs. The presence of two fetuses with clear visualization supports normal development for this stage. The result in (Fig 8) shows **Observations:**The vertebral column of the fetus is clearly visible, indicating a healthy skeletal structure. A placentome, a characteristic structure of ruminant pregnancies, is identified. It is the functional

unit of the placenta that facilitates nutrient and oxygen exchange between the mother and fetus. A fetus is visible, suggesting the pregnancy is progressing normally and It ranges between 120-135 days. **Interpretation:** This image represents a single pregnancy with a well-developed fetus. The placentome's presence confirms maternal-fetal attachment, a vital indicator of a healthy pregnancy.

Table 1. Estrous and duration of Response / hours in different groups of goats

Groups	No/ of goats	Estrus response No -%	Non-estrus response No -%	Duration of Response (Mean± SE)
G 1	7	5 (71.43%)	2 (28.57%)	27.81 ±1.32 b
G 2	7	7 (100%)	0 (0.00%)	36.98 ±0.81 a
G 3	7	2 (28.57%)	5 (71.43%)	29.88 ±1.34 b
Total	21	14	7	---
L.S.D. (P-value)	---	--- (0.0422) *	--- (0.373) *	4.048 ** (0.0001)
Means with different letters in the column are significantly different. * (P≤0.05), ** (P≤0.01)				

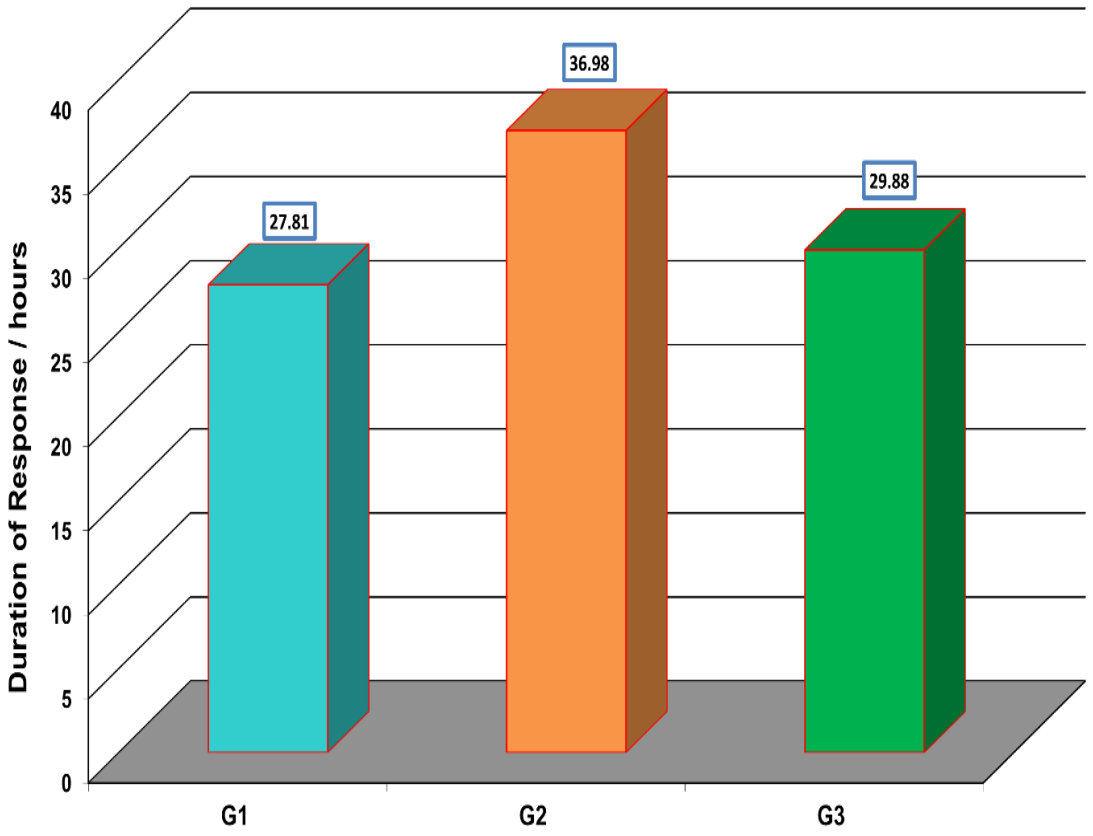

Figure 1. Estrous response and duration of Response / hours in different groups of treated goats.

Table 2 Effects of melatonin and intra-vaginal sponges on reproductive performance of goats

Groups	No. of goats	pregnant goats No -%	non-pregnant goats No -%	Single pregnancy No -%	Twining pregnancy No -%	Conception rate No -%
G 1	7	3 (42.86%)	4 (57.14%)	3 (100%)	0 (0%)	3 (42.86%)
G 2	7	6 (85.71%)	1 (14.29%)	4 (66.7%)	2 (33.3%)	6 (85.71%)
G 3	7	0 (0%)	7 (100%)	0 (0%)	0 (0%)	0 (0%)
Total	21	9 (42.86%)	12 (57.14%)	7 (77.78%)	2 (22.22%)	9 (42.86%)
x^2 Value	-	4.519 *	4.285 *	3.715 *	1.844 NS	4.519 *

Means with different letters in the column are significantly different. * (P≤0.05), non-Significant

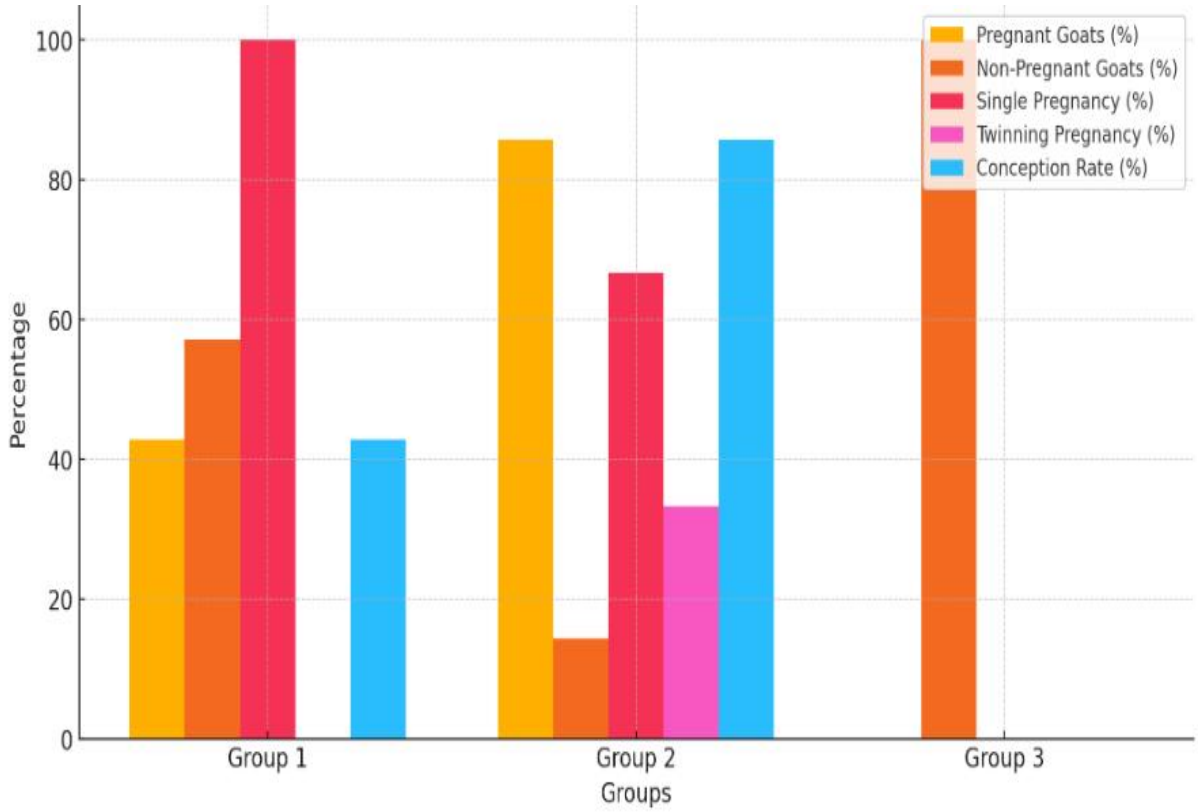

Figure 2. Pregnancy rates in treated and control groups in goats

Groups	Goats	Kidded Goats	Kids	Sex of kids		Viability of kids %		Nature of parturition	
				M No. %	F No. %	Live No. %	Dead No. %	N No. %	D No. %
G 1	7	3	3	2 (66.7%)	1 (33.3%)	3 (100%)	0 (0%)	3 (100)	0 (0.00)
G 2	7	6	8	5 (62.5%)	3 (37.5%)	8 (100%)	0 (0%)	8 (100)	0 (0.00)
G 3	7	0	-	-	-	-	-	-	-
Total	21	9	11	7 (63.64%)	4 (36.36%)	11 (100%)	0 (0%)	11 (100%)	0 (0%)
x^2 Value				3.751 *		1.00 NS	0.00 NS	NS	
Means with different letters in the column are significantly different * (P≤0.05), non-Significant.									

Table 5 Serum progesterone insulin-like growth factor (IGF-1) concentrations ng/ml at different times.

Hormone	Time of collection	Mean ± SE			LSD value
		G1	G2	G3	
Progesterone	Day -0	1.21 ±0.17	1.32 ±0.17	1.08 ±0.25	0.598 NS
	Estrus phase	0.949 ±0.15 b	0.551 ±0.06 b	1.58 ±0.26 a	0.528 **
	Luteal phase	4.03 ±1.26 ab	6.47 ±0.56 a	1.93 ±0.38 b	2.460 **
IGF-1	Day -0	68.56 ±6.73 a	61.48 ±4.05 a	62.18 ±5.88 a	11.73 NS
	Estrus phase	70.68 ±6.49 ab	95.04 ±2.94 a	59.08 ±7.21 b	28.65 **
	Luteal phase	96.77 ±16.11 b	147.14 ±2.93 a	54.05 ±5.84 c	37.81 **
Means with different letters in the row are significantly different ** (P≤0.01), non-Significant					

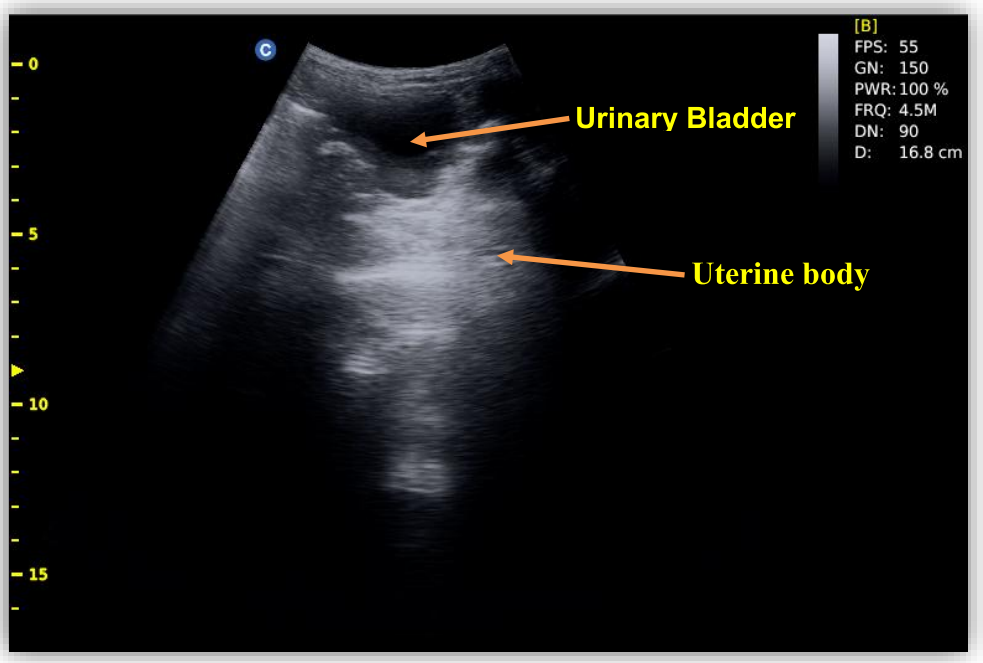

Figure 3. Real time-B-mode Ultrasonographic image of non-pregnant goat using trans rectal examination, U.B: Urinary bladder.

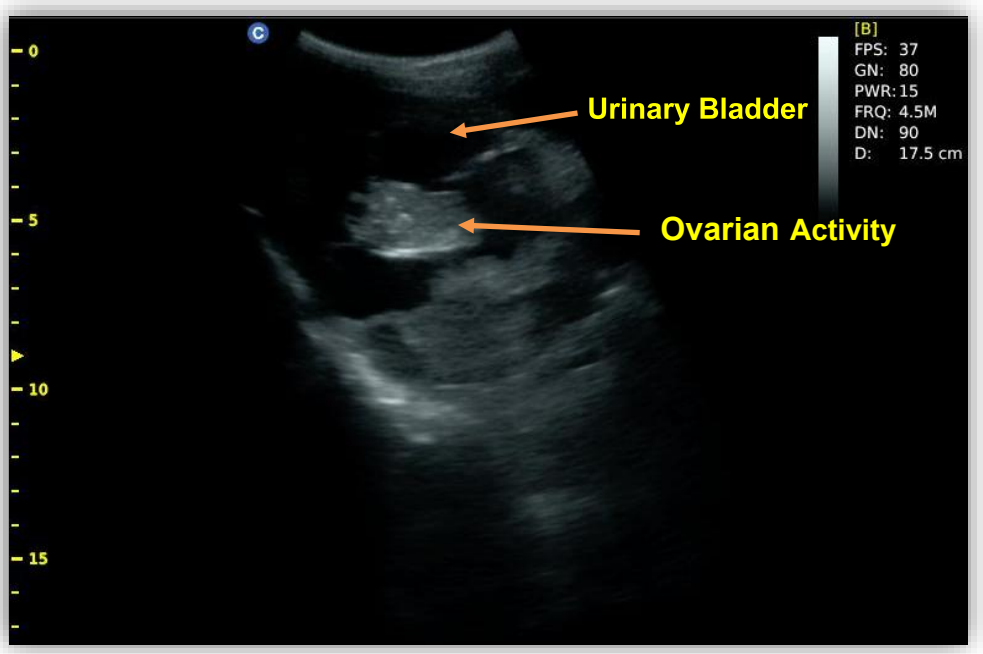

Figure 4. Real time-B-mode Ultrasonographic Image of estrous goat using trans rectal examination showed ovarian activity.

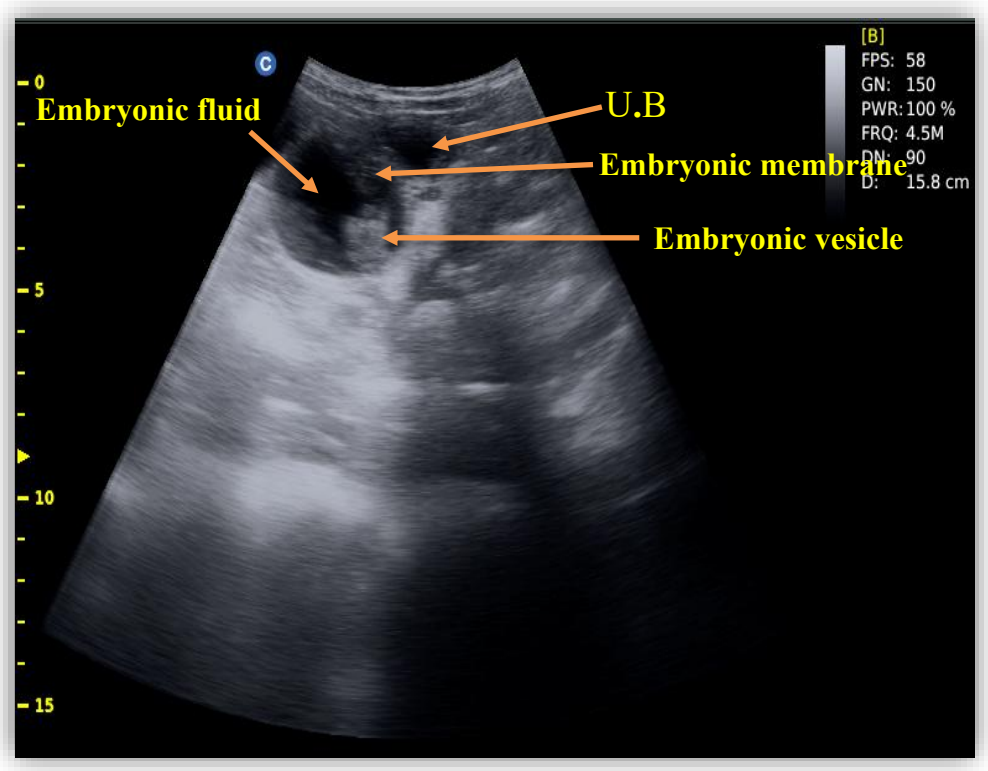

Figure 5. Real time-B-mode Ultrasonographic image of pregnant goat using trans rectal examination on day 30 post mating.

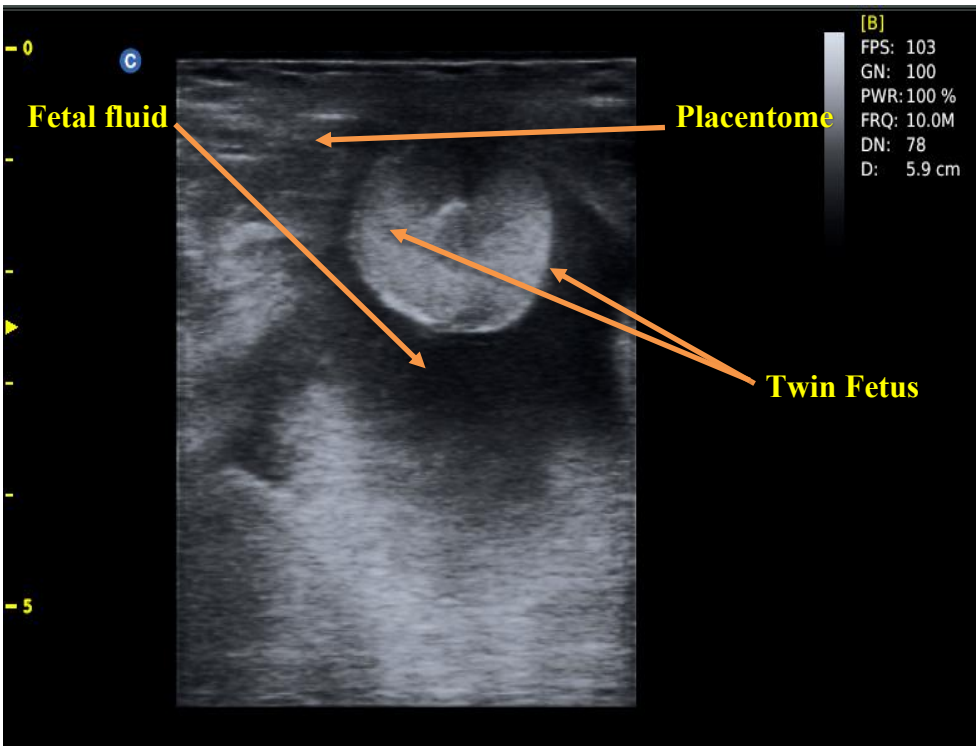

Figure 6. Real time-B-mode Ultrasonographic image of pregnant goat with twin using trans rectal examination on day 40 post mating.

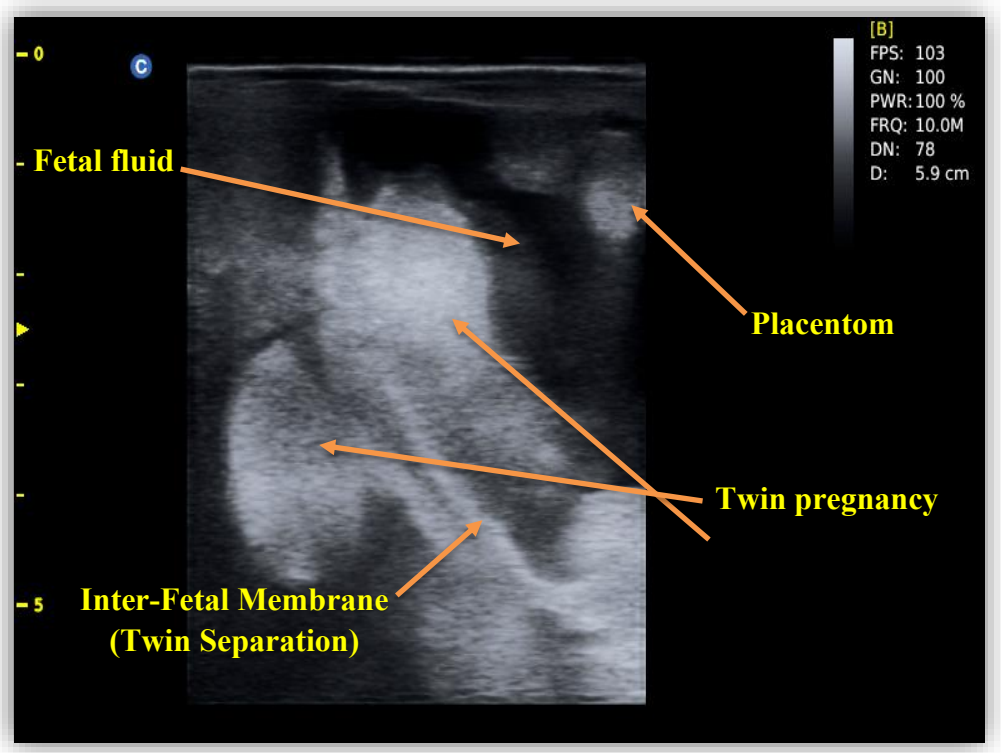

Figure 7. Real time-B-mode Ultrasonographic image of pregnant goat with twin using trans rectal examination on day 60 post mating.

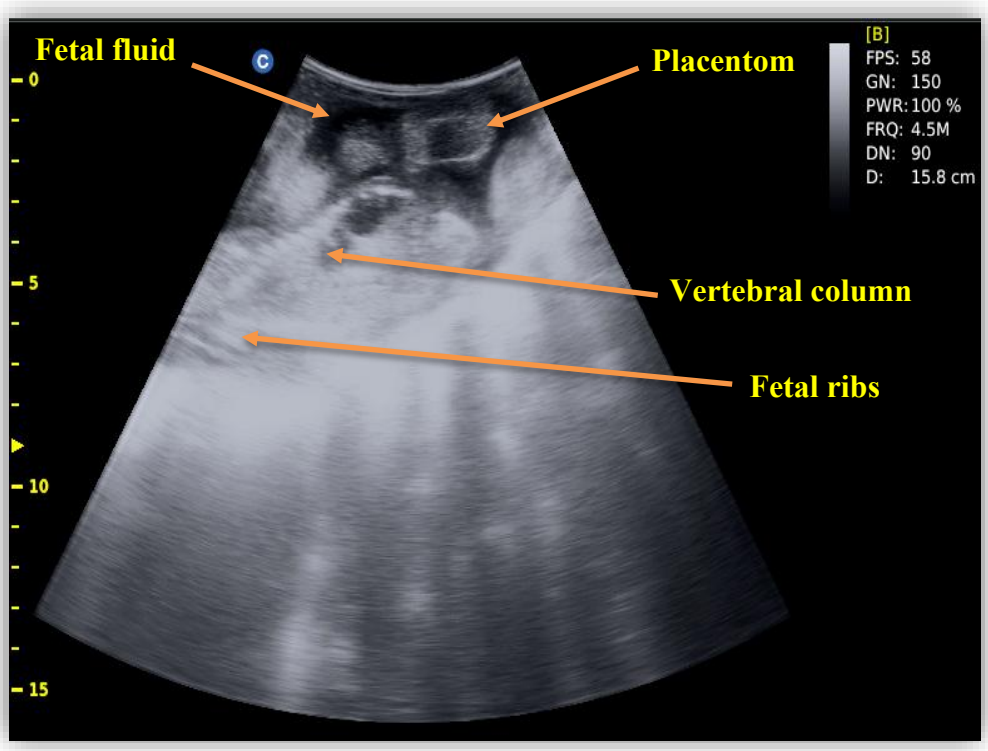

Figure 8. Real time-B-mode Ultrasonographic image of pregnant goat using trans abdominal examination on day 120 post mating.

Discussion

Estrus response and duration response in goats

The findings of the current clinical study revealed that 5 (71.43%), 7 (100 %) and 2 (28.57%) goats in group one, two and three respectively, the expression of estrus sings after synchronization of estrus higher significant difference (P≤0.05) between group two in comparison with groups one and three, this is result has similarities to a prior study of Wondim, et al. (53) who revealed that estrus response in goat was 96.00%, whereas utilizing intra-vaginal progestin (60 mg MAP) for a 12-day period then receiving I.M injection of 400 IU eCG following sponges' removal. Similarly, outcomes were obtained by Kanduri, (54) whoever revealed that the estrus response in adult's goat was 95.00% when they used intra-vaginal sponge impregnated with sixty milligrams MAP for nine days, then received an intramuscular of 300 IU eCG after sponge removal. Furthermore; Al-Tayeb and Hussein, (55), found that the estrus response in ewe was 50,00% (9/10) when utilized 40 mg MAP and administered 500 IU eCG during sponge removal. Nevertheless, this result was bigger than that achieved by Sobayil, (56) and Bamerny et al. (57) They both of them mentioned that the estrus response was 73.33 % and 73.3 % respectively, whereas utilizing differed dosage of MAP and eCG, progesterone sponges were intra-vaginally inserted for 14 days and injected 600 I.U eCG at withdrawal time, utilizing sponges saturated with 40 mg medroxyacetate (MAP) for 14 days and administered 400 IU eCG upon sponge extraction. This may be ascribed to the influence of age, parity, diets, species, therapy, protocol, location and management Kausar et al. (58) and Ungerfeld et al. (59). The total number of non-estrous goats in group two was 0 (00.00%), which was significantly (P≤0.05) less than that of group one (28.57%) and group three (51.43%). The estrous phase duration/hours in group two (36.98 ±0.81) were significantly (P≤0.01) longer than that of group three (29.88 ±1.34) and group one (27.81 ±1.32), this shown in figure 4.2 and table 4.2. Estrus duration of the all groups receiving treatment elevated when compared to that of control, one, especially that of group two (vaginal sponges + eCG) which exhibited the most noticeable increase in estrus duration than that of control and melatonin group, such increment was significant (P≤0.01) That result is in arrangement with Wondim et al. (53) they recorded that the estrus period was 38.6 ±1.64, when utilizing intra-vaginal progesterone (60 mg MAP) for 12 days accompanied by I.M injection of eCG 400 IU following sponge removal. However, this outcome was higher than that recorded by Greyling and Van der Nest, (60) and Sönmez et al. (61), who found that the estrus duration in goats were 31.1 and 30.5 hours, respectively. when they utilized the intra-vaginal sponge filled with 60 mg medroxyprogesterone acetate (MAP) for 14 days and administered with 300 - 750 IU eCG on the day of sponge withdrawal. The result of this study was less than that reported by Kanduri, (54), who reported that the duration of estrus was 52.21 to 48.73 hour, when utilized with MAP for 9 day and administered with 300 IU eCG. The variation may be caused by elevated estrogen levels in the blood created during forced luteolysis and stimulation of follicular development in the ovary by FSH or exogenous eCG. It suggests that elevated levels of serum estrogen levels have been responsible for the extended duration of the estrous period Dogan et al., (62). The results of current study regarding to melatonin group one recorded 71.43% estrous response, while Kumar and Purohit, (63) whom obtained 90% estrous response, The lower estrous response in current study compared to Kumar and Purohit (63) could be attributed primarily to the absence of progesterone, as their synergistic effects enhance estrus synchronization. Additional factors such as breed, environmental conditions, and management practices likely compounded the difference.

Effects of melatonin and vaginal sponges on pregnancy rates in goats

The conception ratios in these studies found that group 2 (vaginal sponges + eCG) had considerably higher values (P≤0.01) than those of group melatonin and control group (85.71%,42.86%% and 0%) respectively. The result is in agreement with Habibizad et al. (64) they discovered that the conception rate in goat was 86.7 %, when they utilized saturated intra-vaginal sponge and gave eCG 500 IU subsequent to sponge withdrawal. Also, higher than that revealed by Greyling and Van der Nest (60); Dogan et al. (62); Mishra et al. (65) and Bamerny et al. (57), they reported that the conception rates were 80%; 52.63%; 81.25%; and 73.3% respectively. High rates of conception suggested that eCG should be given soon after the intra-vaginal progestogens sponge pullout in order to achieve a more consistent and compact ovulation or estrus (66). furthermore, as a result of the hand mating breeding technique, which helps breed a large number of ewes throughout the breeding season by doing so twice a day. Higher percentages of overall singleton and multiple pregnancies in treated groups were 77.78% and 22.22% respectively (Table 4.3). These results were relatively agreement with Habibizad et al. (64) who recorded that the percentage of totals singleton and multiple pregnancy rates were 75.0% and 20.0% respectively. When utilized saturated intra-vaginal sponge and injection with different dosage of eCG after sponge removal. these differences may be due to breeds, time of year and physiological status of animals. However, these results were disagreed with Omran and Hussein, (9) and Pugazharasi et al. (67) who recorded that the percentage of totals singleton and multiple pregnancy rates 50.0%, 50.0%, 17.55% and 61.0% respectively. When used intra-vaginal sponge saturated with different dosage and injection with different dosage of eCG and different time of sponge removal. These variances are dependent on numerous parameters such as breed, age, timing and dose of eCG administration (68). In the melatonin group, the conception rate was 42.86%. This outcome was greater than that reported by Chemineau et al. (69) they recorded that the conception rates was 39%. The higher percentages of totals singleton multiple pregnancy rates in the treated groups were 7 (77.78%) and 2 (22.22%), respectively. This outcome was higher than that reported by Amle et al. (70), they recorded a single pregnancy rate of (37.5%) and a multiple pregnancy rate of (12.5%). Also, higher than that reported by Habibizad et al. (64) they reported a single pregnancy rate of (57.1%) and a multiple pregnancy rate of (14.3%).

Nature of parturition, Viability rate, kidding rate and sex of offspring

The findings in the present research demonstrated statistically significant distinctions in the sex of the offspring in all of the groups that were found 63.64% which reflected male and 36.36% female demonstrating significant differences (P<0.05) regarding male, these findings were similar to those reported by Al-Ameri, (71) and Sharma et al. (72) whom demonstrated significant differences in there ratio and denied with finding of Amle et al. (70) who obtained non-significant variation in the lamb sex ratio. The Results of this study demonstrated that there was non-significant difference between alive fetuses and died fetuses' the proportion between all the experimental groups, this result accorded with Habibizad et al. (64) and Ozis Altincekic and Koyuncu, (73) who reported non-significant difference in alive fetuses and dead fetuses' percentage they denied with AL-Hamedawi et al. (11) and Erdem et al. (74) whom recorded Alive fetuses' percentage was 90% and 88.75%, respectively. and dead fetuses 10% and 24.80%, respectively. In present study, revealed that there was non-significant difference in eutocia and dystocia the proportion between all the experimental groups, this finding accorded with Khatun *et al.,* (75) whom revealed non-significant difference in eutocia and dystocia percentage, and disagreement with AL-Hamedawi et al. (76) and AL-Hamedawi et al. (11) whom obtained 90.6% and 90.0% normal birth, respectively. 9.4% and 10.0% dystocia, respectively. This illustrating that the hormone therapy (P4, eCG and melatonin) has no impact on the kind of kidding of goats.

Progesterone and Serum Insulin like growth factor concentrations ng/ml at different periods.

Progesterone level (ng/ml) throughout estrus at various stages of pregnancies after applying of different hormonal regimens for synchronized estrus in goats in group two (vaginal sponges + eCG) the level of progesterone concentrate (ng/ml) on estrus phase was 0.551±0.06 ng/ml. These results were in agreement with Cetin *et al.,* (77) they recorded that the levels serum progesterone concentrations were 0.32±0.35 ng/ml. when synchronized using progesterone sponges (FGA,20 mg) For a period of eleven days. Later, the cloprostenol 50 mg, and PMSG, 400 IU, were administered intramuscularly 48 h before the removal of sponges. Similarly, Bello *et al.,* (78), recorded that the p4 concentrations during estrus phase were 0.59 ± 0.33 to 0.83 ± 0.79 ng/mL, post sponge withdrawal within 24 to 48 h Also; Patel. *et al.,* (2023), also, found that the concentration of p4 at estrus was 0.63± 0.01. When a synchronized utilizing intra-vaginal progestin sponges (60 mg Medroxyprogesterone acetate, MAP) for eleven days, following PGF2α injection. This decrease in progesterone levels is essential for the initiation of follicular activity and estrus behavior (79). influence of PMSG, the rapid growth of pre-ovulatory follicles occurs, leading to an LH surge and ovulation (80). This manipulation of progesterone levels aligns the hormonal environment to simulate a natural estrous cycle, with a focus on achieving timed ovulation and estrus expression (81). In group 2 (vaginal sponges + eCG) the concentrations of Serum p4 (ng/ml) on luteal phase was 6.47 ±0.56, this result was less than that reported by Zarkawi and Soukouti, (24), they recorded that the concentrations of p4 were 13.41 +4.39 ng/ml. whilst, this outcome was higher than that recorded by Gaafar *et al.,* (82) they revealed that the progesterone levels Concentra were 2.6 to 5.4 ng/ml In Damascus goats' progesterone level through luteal phase. Progesterone is secreted as a result of the establishment of the corpus luteum (C.L) (83). The increase in progesterone levels in goat does from day 5 to day 14 following the commencement of first estrus may be related to the growth and development of the CL Panjaitan *et al.,* (84). The ovaries are deemed active if the progesterone level was 1.0 nmol ⁄ l or greater (85). According to the foregoing, the progesterone test was utilized as a method to verify cyclic ovarian activity in goats. IGF-1 level (ng/ml) throughout estrus at various stages of pregnancies after applying of different hormonal regimens for synchronized estrus in goats. Plasma IGF-I in goats rises two days before estrus, peaks during the preovulatory LH surge, and coincides with behavioral estrus. It then declines around ovulation. According to the same researchers, systemic IGF-I concentrations may rise as a result of IGF-I produced from the ovaries during cyclic activity. (37). In group 2 (vaginal sponges + eCG) the concentrations of Serum IGF-1 (ng/ml) on estrus phase were 95.04 ± 2.94 ng/ml. These results were disagreed with Salhab *et al.,* (86) they revelated that the concentrations of IGF-1 were 97.64 ± 14.2 ng/ml. when estrus cycle in Shami goat. while, this result was higher than that reported by Djuricic *et al.,* (87) who reported that the IGF-1 concentration during estrus phase were 35 to 80 ng/ml out of breeding season in Boer goats in Croatia. Furthermore, much less than the levels that reported by Hashizume *et al.,* (37) who reported that the IGF-1 was 250 ng/ml. Also, less than the levels that reported by Spicer and Zavy, (35) who reported that the IGF-1 was 150 to 200 ng/ml during the estrus cycle in sheep. The level concentration of IGF-1 in serum elevated in conjunction with behavioural estrus in goats Hashizume *et al.,* (37). The function of the insulin-like growth factor I system in the controlling of follicular growth (88,89,90,91). The Serum IGF-1 concentrations (ng/ml) on group 2 at luteal phase were147.14 ng/ml. this result was less than that recorded by Hashizume *et al.,* (37) who reported that the IGF-1 was 150 ng/ml. IGF-1's role in ruminant reproduction has

been the focus of extensive research over the past 20 years Wathes *et al.,* (44); Tamadon *et al.,* (92). This function is complicated since it works at numerous levels, including the center hypothalamus level (93), the local level through its impact on ovarian activity (31,29), the systemic release of IGF-1, largely by the liver, and concomitant local synthesis in multiple reproductive tract tissues (95). IGF-I also indirectly induces angiogenesis in the earlier corpus luteum (96). IGF-I plays an essential role for the development of early corpus luteum via the promotion of angiogenesis, luteinization of granulosa-lutein cells and of oxytocin and progesterone synthesis (97).

Ethical Approval

Prior to conducting any experiments, the experimental protocol and design utilized in the present study were reviewed and sanctioned by the Ethics Committee at the College of Veterinary Medicine, University of Baghdad, Baghdad, Iraq (Number P. G/2002 on 20/10/2024).

Conclusions

Using intravaginal sponges impregnated with medroxy-progesterone acetate with eCG in Iraqi goats can improve reproductive outcomes. This approach, along with estrus synchronization, superovulation, and melatonin implantation, can increase multiple pregnancy rates. These hormonal regimens are safe, affordable, and convenient, without any negative effects on treated animals. Serum progesterone and IGF-I levels in blood of goats follow the estrus and cyclic ovarian activity IGF-I concentrations correlated significantly with progesterone concentrations, progesterone test demonstrated reliability in detecting estrus, evaluation of cyclic ovarian activity and early stages of pregnancy

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Conflict of Interest

The authors declare no conflict of interest.

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