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Ultrasonic and hormonal monitoring for ovarian resumption and uterine involution in postpartum local lactation goats in Iraq

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Abstract

Goat reproduction is valuable since it has an economic impact and medical value in goat farms breeding. Uterine involution in physiological status plays an important role in goat breeding. This study aimed to monitor postpartum uterine rebound using ultrasonographic technique and early postpartum activity of the ovary using progesterone and estrogen assay. Fourteen local breeds of goats were submitted in the present study for examination from day 1-30 after kidding, and repeated examination using transrectal and transabdominal approaches to monitoring uterine diameter. Progesterone and estrogen serum levels were assessed starting from the day 1 of kidding until day 30 of the postpartum period by the Electrochemiluminescence immunoassay. This study was found that the average uterine diameter decreased from 49.3 ±2.94 to 19.6 ±2.04 (mm) ($P \leq 0.05$) between days 1-30 postpartum period. During postpartum days 4,9,14,19,24 and day 30, estrogen serum were 14.04 ±0.81, 7.67 ±0.38, 7.605 ±0.41, 13.138 ±0.79, 6.316 ±0.32 and 10.72 ±0.67, respectively (ng/ml) was significantly higher ($P \leq 0.05$). While the progesterone profile was 0.4935 ±0.11, 0.4815 ±0.07, 0.3955 ±0.07, 0.4478 ±0.14, 0.4346 ±0.12 and 0.5071 ±0.17 (ng/ml). The results revealed that there is significant negative correlation between estrogen and progesterone levels. In conclusion, real-time ultrasound is an appropriate and safe method to monitor the involution of uterine in lactating does, estrogen and progesterone measuring was benefit for monitoring ovarian resumption cycle and the hormonal dynamic postpartum period.

Keyword: estrogen, progesterone, ultrasound, uterus, goats

Introduction:

Rapid uterine involution, and subsequently increase conception after parturition are important to increase the economic income on the farm's animals. Postpartum uterine involution

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and the hormonal profiles of estrogen and progesterone performance a critical role in the reproductive health and productivity of lactating goats (Kandiel *et al.*,2012). Uterine involution, the process by which the uterus returns to its pre-pregnancy state, is decisive for the subsequent fertility of the animals. This process can be efficiently monitored through ultrasonography, which provides comprehensive of the uterine changes occurring in the post-partum period(Zongo *et al.*,2015 and Rasheed *et al.*, 2023).However, evaluation of any changes in the uterus could be done by several techniques, one of which is ultrasound, the ability of ultrasonography to differentiate intrauterine fluid from soft tissue and distinguish between soft tissues based on their conformation makes it better choice than radiography for examination of soft tissue structures(Majama *et al.*,2023).

Monitoring the fluctuations in E2 and P4 levels can provide perception into the fertility and health of the ewe lambs(Alali and Rahawy,2022). Abnormal levels of these hormones can show reproductive issues for instance anestrus, delay of uterine involution , or hormonal imbalances, which can be addressed through veterinary interferences(Tanjung *et al.*,2015). Previous study showed that uterine involution in goats was completed at day 22 (Zongo *et al.*,2015) or at the 28 day (Majama *et al.*,2023) ,26 day (Hussain *et al.*,2016),post-partum period.

The involution of uterus in sheep and goats is categorized by a rapid decrease of uterine diameter and increase rates of contraction, most commonly between the 7th and the 14th days postpartum, demonstrated by measurements of uterine weight and length and decrease in the size of the uterus after parturition ,is the greatest alteration occurring throughout the first few weeks after parturition (Zduńczyk *et al.*,2004 and Majama *et al.*,2023).).In aggregation with ultrasonic monitoring, summarizing the levels of estrogen(E2) and progesterone(P4) is essential for understanding the hormonal guideline of reproductive processes explored the relationship between the serum level of estrogen and progesterone and resumption of ovarian and sexual activity and consequence improved reproductive health in goats (Kandiel *et al.*,2012 and Al-Watar and Hussein,2022) . There are few studies about depend ultrasound scanning for uterine involution in small ruminant in Iraq and hormonal profile during postpartum period in goat. So, this research aims to investigate the uterine involution process and serum levels of hormones, specifically focusing on estrogen and progesterone, in lactating goats using ultrasonographic techniques.

Material and Methods:

Animals

Fourteen local breed Does (aged 1.5-4 years, weight 35-45Kg) were submitted in the present study, and they have 1-3 previous pregnancies. All animals of current study were raised up in animal farm belong to the College of Veterinary Medicine/Diyala University. The animals are kept in one farm under the same environment, management, and feeding system. All does were labeled to improve recording and measurements.

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The Ultrasonographic (U.S) scanning were obtained by Trans-abdominal (TAUS) examination was conducted with 3.5-5 MHz convex array transducer, according to (Muhammad and Aziz ,2022), The transrectal (TRUS) examination was conducted with 5-7.5 MHz linear array transducer, according to (Rasheed *et al*.,2023) the transducer was fastened to a plastic rod (20mm) in diameter, and (30cm) length. Using a real-time B-mode scanner (Welld ultrasound, Shenzhen well. D. Medical Electronics Co. LTD. China). Light wave record and play video, USB 2.0 TV BOX, ultrasound transmission gel. Ultrasonographic examination in four days interval started from Day 1 up to Day 30, after kidding for measuring the diameter of uterine horn(figure-1).

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Figure 1: Uterine involution progress at four days interval (**a, b, c, d, e, f, g , h**)
U.C: uterine caruncle, U.B: urinary bladder, blue arrows represent uterine diameter

Blood Sampling and hormonal assay analysis:

Blood samples (5ml) were collected from jugular vein puncture from all animals from the fourth day PP up to Day 30(4-day interval), concurrently with the ultrasound examinations. The collected

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blood samples were kept in the gel tubes and left for 30 minutes, and then the serum was obtained by centrifugation of the blood at 3000 rpm for 15 minutes and stored in micro-Eppendorf tubes at -20C°, until hormonal assay (Al-Thuwaini ,2021). Concentrations of serum estrogen and progesterone were assayed using the electrochemiluminescence immunoassay "ECLIA" is intended for use on Cobas e411 immunoassay analyzer (Roche/ Germany).

Statistical Analysis: The Statistical Analysis System- SAS (SAS, 2018) program was used to Effect of Postpartum in E2, P4 and Uterine diameter. Least significant difference-LSD ($P \leq 0.05$) was used to significant compare between means (ANOVA/ One way) in this study, to determine the relationship between UD and hormonal profile (E2 and P4) during present study we used the coefficient correlation (R^2) models.

Ethical approval:

The Scientific Ethical Committee of the College of Veterinary Medicine, University of Diyala, Iraq, was approved that the research proposal submitted by (salman hammadi ghareeb ,yaseen mahmood rasheed, mohammed yousif mahmood) Entitled: Monitoring of uterine involution and assessment of subsequent ovarian activity using both ultrasonography and estrogen / progesterone assay in Iraqi goat. Study (Approval no: Vet Medicine (380); June, 2025, Y, M and S).

Results:

In the present study, the results table-1 founded that the maximum estrogen(E2)serum level was (14.04±0.81pg/ml),at the period 1-4 day postpartum, then it decreased significantly ($P \leq 0.05$) with progress of examination period of study, while, the minimum level of E2 was reported on day 15-19 postpartum it was (6.316±0.32pg/ml) figure-2 .Meanwhile, in the present research ,the mean serum level of P4 (ng/ml) are presented in figure-3 from day 1-30 postpartum period ,and showed that the serum level of progesterone was decreased significantly with the advancement of experimental period and reach the minimum level was (0.3955±0.07ng/ml) on day 10-14 postpartum ,in the meantime, the maximum concentration was reported on 25-30 postpartum day(0.5071±0.17ng/ml) with complete uterine involution.

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Table 1: Effect of Postpartum in E2, P4 and Uterine diameter

Postpartum p.(day)	Mean ±SE			No. scan
	E2 (pg/ml)	P4 (ng/ml)	Uterine diam.(mm)	
1-4	14.04 ±0.81 [a]	0.4935 ±0.11 [ab]	49.3 ±2.94 [a]	19
5-9	7.67 ±0.38 [c]	0.4815 ±0.07 [ab]	46.1 ±2.05 [a]	16
10-14	7.605 ±0.41 [c]	0.3955 ±0.07 [b]	35.2 ±1.69 [b]	19
15-19	6.316 ±0.32 [c]	0.4478 ±0.14 [ab]	27.6 ±1.45 [c]	19
20-24	10.72 ±0.67 [b]	0.4346 ±0.12 [ab]	25.2 ±1.61 [c]	15
25-30	13.138±0.79 a	0.5071 ±0.17 [a]	19.6 ±2.04 [d]	15
L.S.D. value	2.074 *	0.1026 *	5.187 *	---
Means having with the different letters in same column differed significantly. * (P≤0.05).				

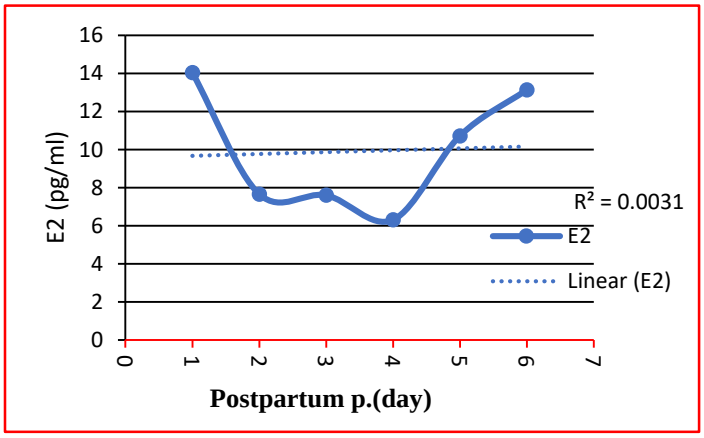

Figure 2: Mean plasma E2 concentration (pg/ml) From day 1 to day 30 pp.1=1-4;2=5-9;3=10-14;4=15-19;5=20-24;6=25-30 days

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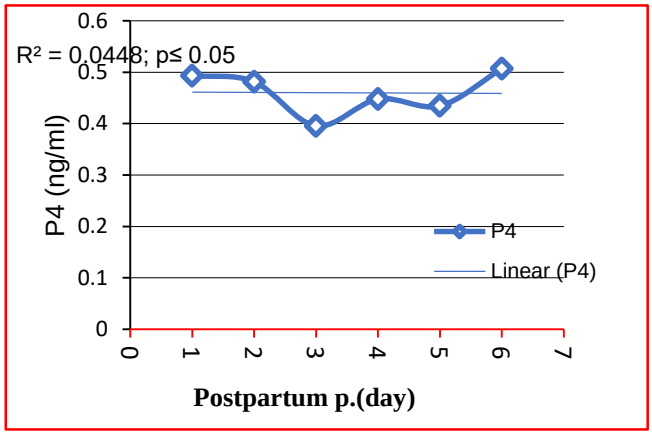

Figure 3: Mean plasma P4 concentration (ng/mL) from day 1 to day 30 pp. 1=1-4;2=5-9;3=10-14;4=15-19;5=20-24;6=25-30 days

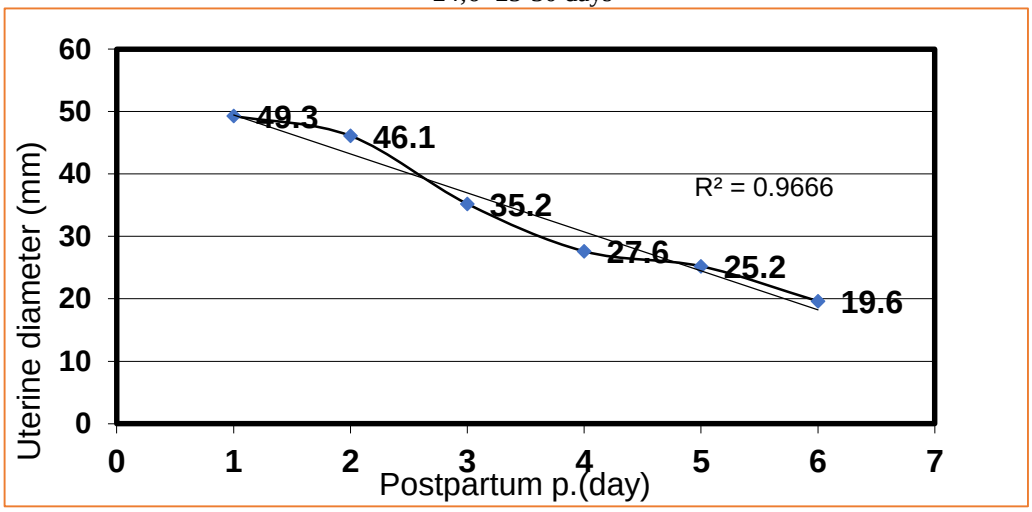

Figure 4: Effect of Postpartum in Uterine diameter. 1=1-4; 2=5-9;3=10-14;4=15-19;5=20-24;6=25-30 days

The uterine involution was considered to be whole when no further decrease in the diameter of uterus for three following scanning was recorded. In the present study, the data showed that the uterine diameter (UD) was decrease significantly (P≤0.05) with the progress of studying period figure-4 . Moreover, it should be noted that the UD was reduced more rapidly after 10 postpartum days. Additionally, the current study founded that very low significant correlation between Estrogen, Progesterone level and UD during studying period it was (R2=0.0031,0.0448, P≤0.05),

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respectively, while strong positive correlation between uterine involution and UD which was R2=0.9666, P≤0.05.

Discussion:

The combination of ultrasonic techniques and hormonal profiling thus offers a comprehensive approach to studying uterine involution and hormonal changes in lactating goats, providing valuable data for improving reproductive management and enhancing the productivity of goat herds (Syed *et al*.,2024 and Goel *et al*.,2016).Furthermore, the PP affected by many factors for instance: season, age of Does ,reproductive status ,lactating hormones level as well as nutrition (Fasulkov,2014).In addition, the serum level of hormones (E2 ,P4) depending upon a variety factors such as breed and species of animal, metabolic rate ,lactation period and hormonal assay technique(Mmbengwa *et al*.,2009 and Ismaeel *et al*., 2023).

In our data, E2 serum level in goats was at the highest significant (P≤0.05) level in the first PP period (1-4day), then started to decline in the following progress experimental period, and the E2 concentration increased slowly after the day 20 well reached a peak level on day 30 postpartum which is close to day 1-4 concentration. The studies have shown similar results such as (Mmbengwa *et al*.,2009 and Alwan *et al*.,2010), who reported that increased level of E2 during parturition and then, still in the basal concentration after 4 days postpartum and remain elevated of level by day 20 after kidding. On the other hand, the high serum level of E2 in goats during 1-4day postpartum, can be elucidated by the action of oxytocin hormone that stimulates cells of endothelial in the endometrium to release the prostaglandin F2α (PGF2α) leading to a rise in regression of corpus luteum (CL) and subsequential decline of P4 level causing cessation negative feedback mechanism on the hypothalamus gland to release Gonado-releasing hormone(GnRH),which lead to ovarian resumption activity causing elevated E2 serum concentration(Mmbengwa *et al*.,2009 and Hussain *et al*.,2016).

On the other hand, the data of present study founded that the P4 level was significantly decrease from 0.4935 ±0.11ng/ml to 0.3955 ±0.07ng/ml during days 1-4 and 10-14, respectively. Regarding of progesterone assay during experimental periods in general is agree with (Goel *et al*.,2016 ; Hussain *et al*.,2016 and Al-Watar and Hussein,2022) , in Jakhrana goats , local goats and local cow, respectively. Who revealed that the event of parturition in cow and goats is trigging by lyses of luteal tissues, which lead to lowering of serum level of P4(Kumala *et al*.,2022 and Raja *et al*.,2024). In addition ,the lower concentration of P4 in the current study during earlier pp period point to inhibit Gonadotropic-releasing hormone secretion due to lactating(Diatmono *et al*.,2024).

Additionally, the results of Takayama *et al*.(,2010)in Shiba goats and Hussain *et al*.,(2016)in local Iraqi goats were smeller and constant with a present results it is known that the gradual increase of progesterone concentration after second week -fourth week postpartum due to resumption of pp ovarian cyclicity. Regarding P4 profile during pp period in local goats ,data of percent study

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(tab.1)(fig.2),were reported lower serum progesterone level compared to previous studies (Goel *et al.*,2016 ;Alali and Rahawy,2022 and Ismaeel *et al*., 2023),the differences could be attributed to many aspects such as hormonal assay procedure ,breed and species of animals, management ,nutrition , as well as environmental conditions(Sitaresmi *et al*.,2017 and Mpendulo *et al*.,2020).

In the meanwhile, the post-partum fertility is built mainly on two factors the resumption activity of ovaries and the uterine involution. Ultrasound is routinely secondhand to monitor post-partum uterus. According to the present results, the ultrasonographic scanning showed that a significant decrease in the uterine diameter which was 49.3 ±2.94, 46.1 ±2.05, 35.2 ±1.69, 27.6 ±1.45, 25.2 ±1.61and 19.6 ±2.04(mm) at a day 1-4,5-9,10-14,15-19,20-24 and 25-30, respectively (table-1).These results is similar to the study showed by Hussain *et al*.,(2016) and Gümüş, and Akkuş (2024) which conducted on the local Iraqi goats and Awassi ewe, respectively, who confirmed that a significant decrease of UD during second week after parturition until the fourth week.

On the other hand ,the mean time required for complete uterine involution was 25-30 day pp period and was categorized by a minor sectional uterine diameter(≤2cm)(figure-).These observed was in agreement with those of (Al-Ekpi *et al*.,2010 ;Zongo *et al*.,2015 and Bayoumi *et al*.,2021),who founded that uterine diameter reduction to the standard measurement was started by 25 day and complete involution of uterus at a day 35 postpartum. Contrary to the our result, Goel et al.,(2016) ,show that slower uterine involution and observed that uterine regression in Jakhrana goats completely at 45 day pp ,in contrast to earlier studies (Takayama *et al*.,2010),which founded the finish of uterine involution in Shiba goats by day 19.The inconstant regarding the period required for a complete involution of uterus may attributed to management factors, suckling-milk ,breed differences ,effect of seasons and improper animals restraining subsequent in inopportune of a structures examine(Greyling,2000). Additionally, in the current study founded that a very low significant correlation between E2 and P4 concentration and UD. These result is similar to Hyder and Ali,(2008),who documented no correlation between onset of ovarian hormones resumption and uterine involution .In contrast to the results described by Badawi *et al*.(2014),who founded that a significant correlation between P4 concentration and UD .This divergence could be attributed to differences in the animals breed and individual physiology variation ,season, lactating period and hormonal measurement methods(Pehlivan *et al*.,2017 ; Yazici *et al*.,2018 and Muhammad and Aziz ,2022).

Conclusions

The results of this study concluded that the combination of ultrasonographic techniques and hormonal profiling thus offers a comprehensive approach to studying uterine involution and hormonal changes in lactating goats, and could benefit veterinarian to fix optimum period for return uterus to normal structure as well as providing valuable data for improving reproductive management and enhancing the productivity of goat herds.

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Authors Contributions

Yassen, M.R his contrition mainly in the application of ultrasonography. Salman, H.G contributed in achieving hormonal assessment as blood sampling and hormonal laboratory test. Mohammed, Y. M contribute in Academic writing of this paper.

Conflict of Interest

There is no conflict of interest among authors of this research paper.

Highlight of Article:

1-The post-partum period is a decisive factor for resumption and improving of reproductive performance.

2-These studies investigate the important of ultrasonic monitoring and ovarian hormones profile in understanding the reproductive physiology of lactating doe.

3-There was a strong negative correlation between E2, P4 levels and uterine involution.

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