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Birendra Singh
Ph.D. Scholar, Division of LPM, ICAR-National Dairy Research Institute, Karnal, Haryana, India

PS Pramanik
Professor, HOD, LPM Department, ANDUAT, Kumarganj, Ayodhya, Uttar Pradesh, India

Jaswant Singh
Professor, AGB Department, ANDUAT, Kumarganj, Ayodhya, Uttar Pradesh, India

KD Singh
Assistant Professor, LPM Department, ANDUAT, Kumarganj Ayodhya, Uttar Pradesh, India

Hemant Kumar Singh
YP-II Department of Veterinary Parasitology. ANDUAT, Kumarganj, Ayodhya, Uttar Pradesh, India

Gaurav Kumar
TRA, Department of Animal Physiology, RLBCAU, Jhansi, Uttar Pradesh, India

Shamshad Ali
Ph.D. Scholar, Animal Physiology Division, ICAR-IVRI, Bareilly, Uttar Pradesh, India

Corresponding Author:
Birendra Singh
Ph.D. Scholar, Division of LPM, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Assessment of blood biochemical and haematological profiles during peri-parturient period in Muzaffarnagari sheep

Birendra Singh, PS Pramanik, Jaswant Singh, KD Singh, Hemant Kumar Singh, Gaurav Kumar and Shamshad Ali

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Abstract
The peri-parturient period in sheep, particularly in indigenous breeds like Muzaffarnagari sheep, is marked by substantial physiological changes crucial for parturition and lactation. However, limited research has focused on evaluating blood biochemical and haematological profiles during this critical period. This study aimed to address this gap by examining these profiles in Muzaffarnagari sheep throughout the peri-parturient period. The peri-parturient haemato-biochemical profiling of 10 Muzaffarnagari ewes was done at Livestock Farm Complex, A.N.D.U.A.T., Kumarganj. Results revealed notable fluctuations in blood profiles during the peri-parturient period. The overall average blood haemoglobin level remained relatively stable a week before parturition (10.96±0.27 g/dl), at the time of parturition (10.96±0.30 g/dl), and a week after parturition (10.82±0.32 g/dl). Similarly, the total blood RBC count increased at parturition (9.81±0.34 106/µl) and decreased postpartum (9.24±0.28 106/µl). Total WBC count exhibited a similar trend, peaking at parturition (8.41±0.19 103/µl). Lymphocyte count decreased at parturition (65.9±1.57%) and rose postpartum (69.4±1.83%), while neutrophil count increased at parturition (24.2±0.94%) and decreased postpartum (23.5±0.54%). Serum calcium, inorganic phosphorus, total protein, and cholesterol levels displayed fluctuations across the peri-parturient period. These findings provide valuable insights into the dynamic changes occurring in blood biochemical and haematological profiles in Muzaffarnagari sheep during the peri-parturient period, essential for effective management and intervention strategies to ensure optimal health and productivity of both ewes and lambs.

Keywords: Peri-parturent, lambing, serum calcium, serum cholesterol, serum total protein

Introduction
Sheep are raised for wool, meat, and sometimes milk, especially in arid and semi-arid regions. Sheep farming requires low investment, offers quick returns, and is suitable for small and landless farmers. India's climate allows for sheep farming as a profitable venture. Sheep contribute significantly to the rural economy and provide a livelihood for many.
During the peri-lambing period, assessment of blood biochemical is helpful for the evaluation of animal's health, and any changes in their normal blood biochemical parameters are helpful in deciding the feeding or treatment to ameliorate any changes so the animals' health status is maintained at normal.

Material and Methods
The peripartum study on Muzaffarnagari sheep was conducted at Livestock Farm Complex, Acharya Narendra Dev University of Agriculture and Technology; Kumarganj Ayodhya. Blood samples of the sheep were collected from advanced pregnant sheep one week before on the day of lambing and one week after the lambing. Blood samples were analysed using Blood haemocytometer, Sahli's Haemoglobinometer and Using ELISA-Kit to know the status of animal Mineral profile in peri-parturient period of Muzaffarnagari Sheep.

Statistical Analysis
All the collected data were analysed statistically using ANOVA in IBM-SPSS-19 Version Software. And graphs were plotted accordingly using the Microsoft Excel 2010 Software.

Results

Haemoglobin

Average blood haemoglobin level one week before parturition, at the time of parturition and one week after parturition in ewes has been presented in table 1. Overall average blood haemoglobin level one week before parturition, at the time of parturition and one week after parturition in ewes was 10.96±0.27 g/dl, 10.96±0.30 g/dl and 10.82±0.32 g/dl respectively. At same period in ewes irrespective of sex of lambs born the haemoglobin concentration was higher in female lamb ewes (10.96±0.27 g/dl, 11.58±0.37 g/dl and 11.52±0.39 g/dl) than the male lamb ewes (9.96±0.26 g/dl, 10.34±0.27g/dl and 10.12±0.22 g/dl). Analysis of variance indicated no significant effect of periods on haemoglobin level.

Table 1: Average blood haemoglobin level (g/dl) one week before parturition and at the time of parturition in ewes and one week after parturition

Sex of Lambs	Haemoglobin level		
	One week before parturition	At parturition	One week after parturition
Male	9.96±0.26	10.34±0.27	10.12±0.22
Female	10.96±0.27	11.58±0.37	11.52±0.39
Overall	10.46±0.24	10.96±0.30	10.82 0.32

RBC Count

Average blood RBC count; one week before parturition, at the time of parturition and one week after parturition in ewes have been presented in table 2. Overall average blood RBC count one week before parturition, at the time of parturition and one week after parturition in ewes was 9.42±0.33 10^6/µl, 9.81±0.34 10^6/µl and 9.24±0.28 10^6/µl respectively. At same period in ewes irrespective of sex of lambs born the total RBC count was higher in male lamb ewes (9.66±0.56 10^6/µl, 10.04±0.56 10^6/µl and 9.4±0.47 10^6/µl) than the female lamb ewes (9.18±0.38 10^6/µl, 9.58±0.42 10^6/µl and 9.08±0.34 10^6/µl). Analysis of variance indicated no significant effect of periods on RBC count.

Table 2: Average RBC count (10^6/µl) one week before parturition and at the time of parturition in ewes and one week after parturition

Sex of Lambs	RBC count (10^6/µl)		
	One week before parturition	At parturition	One week after parturition
Male	9.66±0.56	10.04±0.56	9.4±0.47
Female	9.18±0.38	9.58±0.42	9.08±0.34
Overall	9.42±0.33	9.81±0.34	9.24±0.28

Total WBC Count

Average blood total WBC count; one week before parturition, at the time of parturition and one week after parturition in ewes have been presented in table 3. Overall average blood WBC count one week before parturition, at the time of parturition and one week after parturition in ewes was 8.01±0.16 10^3/µl, 8.41±0.19 10^3/µl and 8.18±0.16 10^3/µl respectively. At same period in ewes irrespective of sex of lambs born the total WBC count was higher in male lamb ewes (8.04±0.31 10^3/µl, 8.54±0.35 10^3/µl and 8.28±0.31 10^3/µl) than the female lamb ewes (7.98±0.14 10^3/µl, 8.28±0.17 10^3/µl and 8.08±0.14 10^3/µl). Analysis of variance indicated no significant effect of periods on WBC count.

Table 3: Average WBC count (10^3/µl) one week before parturition and at the time of parturition in ewes and one week after parturition

Sex of Lambs	WBC count (10^3/µl)		
	One week before parturition	At parturition	One week after parturition
Male	8.04±0.31	8.54±0.35	8.28±0.31
Female	7.98±0.14	8.28±0.17	8.08±0.14
Overall	8.01±0.16	8.41±0.19	8.18±0.16

Average Lymphocyte count

Average blood lymphocyte count; one week before parturition, at the time of parturition and one week after parturition in ewes have been presented in table 4. Overall average blood lymphocyte count one week before parturition, at the time of parturition and one week after parturition in ewes were 68.4±1.13, 65.9±1.57 and 69.4±1.83 respectively. At same period in ewes irrespective of sex of lambs born the average lymphocyte count was higher in male lamb ewes (70.6±1.07, 68.6±2.29 and 73.4±2.24) than the female lamb ewes (66.2±1.46, 63.2±1.46 and 65.4±1.44). Analysis of variance indicated no significant effect of periods on WBC count.

Table 4: Average Lymphocyte count one week before parturition and at the time of parturition and one week after parturition in ewes

Sex of Lambs	Lymphocyte count		
	One week before parturition	At parturition	One week after parturition
Male	70.6±1.07	68.6±2.29	73.4±2.24
Female	66.2±1.46	63.2±1.46	65.4±1.44
Overall	68.4±1.13	65.9±1.57	69.4±1.83

Average Neutrophil count

Average blood neutrophil count; one week before parturition, at the time of parturition and one week after parturition in ewes have been presented in table 5. Overall average blood neutrophil count one week before parturition, at the time of parturition and one week after parturition in ewes were 22.1±1.10, 24.2±0.94 and 23.5±0.54 respectively. At same period in ewes irrespective of sex of lambs born the average lymphocyte count was higher in female lamb ewes (24.8±0.97, 26±1.14 and 24.4±0.68) than the male lamb ewes (19.4±0.93, 22.4±1.03 and 22.6±0.68). Analysis of variance indicated no significant effect of periods on WBC count.

Table 5: Average Neutrophil count one week before parturition and at the time of parturition and one week after parturition in ewes

Sex of Lambs	Neutrophil count		
	One week before parturition	At parturition	One week after parturition
Male	19.4±0.93	22.4±1.03	22.6±0.68
Female	24.8±0.97	26±1.14	24.4±0.68
Overall	22.1±1.10	24.2±0.94	23.5±0.54

Average eosinophil count

Average blood eosinophil count; one week before parturition, at the time of parturition and one week after parturition in ewes have been presented in table 6. Overall average blood eosinophil count one week before parturition, at the time of parturition and one week after parturition in ewes were 3.7±0.26, 4.1±0.31 and 3.3±0.40 respectively. At same period in ewes irrespective of sex of lambs born the average lymphocyte count was higher in male lamb ewes

(3.8±0.37, 4.4±0.51and 3.2±0.66) than the female lamb ewes (3.6±0.40, 3.8±0.37 and 3.4±0.51). Analysis of variance indicated no significant effect of periods on WBC count.

Table 6: Average Eosinophil count One week before parturition and at the time of parturition in ewes and One week after parturition

Sex of Lambs	Eosinophil count		
	One week before parturition	At parturition	One week after parturition
Male	3.8±0.37	4.4±0.51	3.2±0.66
Female	3.6±0.40	3.8±0.37	3.4±0.51
Overall	3.7±0.26	4.1±0.31	3.3±0.40

Average serum Calcium level

Average serum calcium level one week before parturition, at the time of parturition and one week after parturition in ewes has been presented in table 7, Overall average serum calcium level one week before lambing and one week after lambing was found 8.84±0.27 mg/dl and 8.53±0.21 mg/dl respectively; and it was higher than the calcium level at parturition 8.39±0.21 mg/dl. In comparison with the sex of the lamb it was higher in male lamb ewes than the female lamb ewes. The values of calcium level for male lamb ewe, one week before parturition and one week after parturition were 9.54±0.21 mg/dl and 9.09±0.12 mg/dl and the lowest level was at the time of parturition (8.96±0.11mg/dl). Same pattern of calcium level for female lamb ewes was also recorded in the table 7 and one week before parturition and one week after parturition it was 8.14±0.19 mg/dl and 7.96±0.17 mg/dl and lowest level of calcium was at the time of parturition 7.82±0.12 mg/dl. (Fig.-1).

Table 7: Average serum Ca; one week before parturition and at the time of parturition and one week after parturition in ewes

Sex of Lambs	Serum Calcium level (mg/dl)		
	One week before parturition	At parturition	One week after parturition
Male	9.54±0.21	8.96±0.11	9.09±0.12
Female	8.14±0.19	7.82±0.12	7.96±0.17
Overall	8.84±0.27	8.39±0.21	8.53±0.21

Serum Inorganic Phosphorus

Average serum inorganic Phosphorus level; one week before parturition, at the time of parturition and one week after parturition in ewes has been presented in table 8, Overall average serum inorganic phosphorus one week before lambing and one week after lambing were found 4.45±0.18 mg/dl and 4.37±0.20 mg/dl respectively; and it was higher than the serum inorganic phosphorus level at parturition 4.30±0.18 mg/dl. In comparison with the sex of the lamb it was higher in male lamb ewes than the female lamb ewes. The values of inorganic phosphorus level for male lamb ewe, one week before parturition and one week after parturition were 4.93±0.15 mg/dl and 4.79±0.26 mg/dl and the lowest level was at the time of parturition (4.72±0.17 mg/dl). Same pattern of inorganic phosphorus level for female lamb ewes was also recorded in the table 8 and one week before parturition and one week after parturition it was 3.97±0.10 mg/dl and 3.95±0.13 mg/dl and lowest level of inorganic phosphorus was at the time of parturition 3.87±0.17 mg/dl. (Fig.-2)

Table 8: Average serum inorganic Phosphorus level; one week before parturition and at the time of parturition and one week after parturition in ewes

Sex of Lambs	Serum inorganic Phosphorus (mg/dl)		
	One week before parturition	At parturition	One week after parturition
Male	4.93±0.15	4.72±0.17	4.79±0.26
Female	3.97±0.10	3.87±0.17	3.95±0.13
Overall	4.45±0.18	4.30±0.18	4.37±0.20

Serum Total Protein

Average serum total protein level; one week before parturition, at the time of parturition and one week after parturition in ewes has been presented in table 9, Overall average serum total protein one week before parturition and one week after parturition was found 6.83±0.12 g/dl and 6.75±0.10 g/dl respectively; and it was higher than the serum total serum protein level at parturition 6.62±0.12 g/dl. In comparison with the sex of the lamb it was higher in male lamb ewes than the female lamb ewes. The values of total serum protein level for male lamb ewe, one week before parturition and one week after parturition were 7.12±0.09 g/dl and 7.03±0.09 g/dl and the lowest level was at the time of parturition (6.94±0.11 g/dl). Same pattern of serum total protein level for female lamb ewes was also recorded in the table 9 and one week before parturition and one week after parturition it was 6.53±0.09 g/dl and 6.47±0.08 g/dl and lowest level of inorganic phosphorus was at the time of parturition 6.31±0.08 g/dl. (Fig.-3).

Table 9: Average serum Total Protein; one week before parturition and at the time of parturition and one week after parturition in ewes

Sex of Lambs	Serum Total Protein (g/dl)		
	One week before parturition	At parturition	One week after parturition
Male	7.12±0.09	6.94±0.11	7.03±0.09
Female	6.53±0.09	6.31±0.08	6.47±0.08
Overall	6.83±0.12	6.62±0.12	6.75±0.10

Average Serum Cholesterol

Average serum cholesterol level one week before parturition, at the time of parturition and one week after parturition in ewes is presented in table 10. It shows a increasing trend of serum cholesterol one week before parturition to at the time of parturition and decline slightly after one week of parturition. Overall serum cholesterol level one week before parturition and at time of parturition was 115.54±2.93 mg/dl and 121.63±2.73 mg/dl and one week after parturition it started decreasing and the values was 120.24±2.27 mg/dl. The serum cholesterol level was slight higher in male lamb ewes than the female lamb ewes. The serum cholesterol level for male lamb ewes one week before parturition, at the time of parturition and one week after parturition in ewes were 119.32±4.23 mg/dl, 125.68±3.23 mg/dl and 124.15±1.97 mg/dl respectively. (Fig.-4)

Table 10: Average serum Cholesterol; one week before parturition and at the time of parturition and one week after parturition in ewes

Sex of Lambs	Serum Cholesterol (mg/dl)		
	One week before parturition	At parturition	One week after parturition
Male	119.32±4.23	125.68±3.23	124.15±1.97
Female	111.77±3.70	117.59±3.86	116.32±3.42
Overall	115.54±2.93	121.63±2.73	120.24±2.27

Average serum glucose

Average serum glucose level one week before parturition, at the time of parturition and one week after parturition in ewes has been presented in table-11. Average blood glucose level in ewes carrying male lambs was found to be 72.74±1.30 mg/dl and 95.50±1.89 mg/dl on one week before expected date of parturition and one week after parturition respectively, and 95.50±1.89 mg/dl at parturition. The values do not differ statistically with each other. In the ewes carrying female lambs, the values were 68.92±2.04 mg/dl (one week before expected date of parturition), 62.98±1.54 mg/dl (one week after parturition) and 91.52±1.29 mg/dl (at parturition). These values also do not differed statistically. Overall average blood glucose level one week before parturition was noted as 70.83±1.30 mg/dl, 63.91±1.18 mg/dl (One week after parturition) and 93.51±1.27 mg/dl (at parturition). Analysis of variance does not indicated significant effect of periods on blood glucose level. (Fig.-5)

Table 11: Average serum Glucose; one week before parturition and at the time of parturition and one week after parturition in ewes

Sex of Lambs	Serum Glucose		
	One week before parturition	At parturition	One week after parturition
Male	72.74±1.30	95.50±1.89	64.84±1.86
Female	68.92±2.04	91.52±1.29	62.98±1.54
Overall	70.83±1.30	93.51±1.27	63.91±1.18

Discussion

Haemoglobin

It was apparent that overall average blood haemoglobin concentration was highest at parturition (10.96±0.30 g/dl) followed by a week after parturition (10.82±0.32 g/dl) and a week before expected date of parturition (10.46±0.24 g/dl) in ewes irrespective of sex of lambs born. The concentration was also highest at parturition in ewes carrying female and male lambs as compared to other two periods before parturition but the differences were non-significant. Analysis of variance showed that the effect of periods on haemoglobin concentration was non-significant. The result indicated an increasing trend in haemoglobin level and it was highest on the day of parturition. Increase in blood haemoglobin level at parturition was also reported by El-Sherif and Assad, (2001) [3] in sheep. Jacob and Vadodaria (2001) [5] opined that increase in PCV and haemoglobin at lambing could be attributed to the stimulated erythropoiesis associated with haemoglobin formation as well as due to the result of squeezing out of blood from the stored organs.

Total RBC/erythrocyte count

Overall average total erythrocyte count was estimated to be the highest at parturition (9.81±0.34 x 10^6/µl) followed by a week after parturition (9.24±0.28 x 10^6/µl) and a week before expected date of parturition (9.42±0.33 x 10^6/µl) in ewes in this study. In this study an increasing trend in total erythrocyte count was found and the count was highest on the day of parturition. Iriadam (2007) [4] reported RBC count 20.94±1.54 x 10^6 mm^3 at parturition in Kilis does. Above results showed that at parturition erythrocyte count was increased, this is in agreement with the present findings.

Total WBC count

Overall average total WBC count was estimated to be the highest at parturition (8.41±0.19 x 10^3/µl) followed by a week after parturition (8.18±0.16 x 10^3/µl) and a week before expected date of parturition (8.01±0.16 x 10^3/µl) in ewes in this study. The increase in total WBC count might be due to acute neutrophilia, accompanied by moderate lymphopoenia and marked eosinophilia and also due to involvement of adrenal cortex in the process of parturition. The leucocytic changes consisting of leucocytosis with neutrophilia, lymphocytopenia and eosinopenia are consistent with ACTH-mediated changes associated with stress (Merril and Smith, 1954, Prasse and Duncan, 1976) [7, 9].

Lymphocyte count

Overall average lymphocyte count was lowest at parturition (65.9±1.57%) as compared to the count a week before expected date of parturition (68.4±1.13%) and a week after parturition (69.4±1.83%) in ewes irrespective of sex of lambs born. The result showed decreasing trend in lymphocyte count and the count was lowest on the day of parturition. The variability in lymphocytes is such and it might be due to the involvement of adrenal cortex in the phenomenon of parturition in ewes.

Neutrophil count

Overall average neutrophil count was highest at parturition (24.2±0.94%), as compared to the count a week before expected date of parturition (22.1±1.10%) and a week after parturition (23.5±0.54%) in ewes. Analysis of variance showed that the effect of periods on the count was non-significant. The result showed increasing trend in neutrophil count. Increase in neutrophil count at parturition in sheep was also reported by Iriadam (2007) [4].

Eosinophil Count

Overall average blood eosinophil count was highest at parturition (4.1±0.31%) than a week before parturition (3.7±0.26%), and a week after parturition in ewes (3.3±0.40%) respectively. Analysis of variance showed non-significant changes in eosinophil count. These results were in contrast as reported by Iriadam (2007) [4].

Average serum Calcium level

The result indicated that the overall average serum calcium level was lowest at parturition (8.39±0.21 mg/dl) in comparison to the level recorded at a week before parturition (8.84±0.27 mg/dl) and a week after parturition in ewes (88.53±0.21 mg/dl). In this study, the results indicated decreasing trend in serum calcium level. The decrease in calcium level during partum supports the view that the maternal demand for calcium increases most rapidly in late pregnancy. Sireli *et al.* (2006) [10] reported statistically higher serum calcium level at 2nd and 4th months than other months of gestation and decreased level at 5th months. Yildiz *et al.* (2005) [11] reported statistically significant decrease ($p< 0.01$ and $p< 0.05$) on day 100 of pregnancy for calcium levels in sheep. Iriadam (2007) [4] also reported marked ($p< 0.01$) decrease in calcium level during late pregnancy, parturition and the 3rd week post-partum. Moghaddam *et al.* (2008) [8] also concluded similarity with the present study, the level of calcium concentration in the serum in the prepartum period was higher than the postpartum period significantly ($p<0.01$) in goats.

Serum Inorganic Phosphorus

The result indicated that the overall average serum inorganic phosphorus level was lowest at parturition (4.30±0.18 mg/dl) in comparison to the level recorded at a week before parturition (4.45±0.18 mg/dl) and a week after parturition in ewes (4.37±0.20 mg/dl). Yildiz *et al*. (2005) [11] reported that the twin pregnant sheep were found to have lower ($p< 0.05$) serum inorganic phosphorus levels than sheep pregnant with one foetus on day 100 and 150 which is in agreement with present findings.

Total Serum Protein

In the present study overall average total serum protein level was recorded to be the lowest at parturition (6.62±0.12 g/dl) as compared with a week after parturition (6.75±0.10 g/dl) and a week after parturition (6.83±0.12 g/dl). Results indicated decreasing trend in total serum protein level. Decrease in total serum protein level at parturition was also reported by (Iriadam, 2007) [4]. Decrease in total serum protein at parturition might be due to utilization of immunoglobulin for cholesterol synthesis. Significant increase in plasma protein in ewes was recorded by El-Sherif and Assad (2001) [3] at the 6th week of pregnancy but the values were found to be decreased throughout the 16th - 18th week of pregnancy. Agrawal *et al.* (2007) [1] recorded highest total plasma protein level in the mid gestation in ewes which declined during the late gestation.

Average serum Cholesterol

Overall average serum cholesterol level was estimated to be 121.63±2.73 mg/dl at parturition in ewes, which is significantly higher than the rest two groups a week before parturition (115.54±2.93 mg/dl) and a week after parturition (120.24±2.27 mg/dl). The variation in cholesterol level was non-significant but an increasing trend in cholesterol level was marked from pre-partum stage to the date of parturition. The values obtained in the present study were lower than the values reported by Iriadam (2007) [4]. Jacob and Vadodaria (2000) [6] reported significant ($p< 0.01$) differences in total serum cholesterol levels at pre-partum and different post-partum stages. Variation in values might be due to variation in breed or environment. Agrawal *et al.* (2007) [1] reported that total plasma cholesterol level was highest in mid gestation and declined in late gestation which is not in accordance with the present finding. They further stated that decline in the total plasma cholesterol level with advancement of pregnancy might possibly be due to concomitant change in the thyroid hormone.

Average serum Glucose

The result indicated that the overall average serum glucose level was highest at parturition (93.51±1.27 mg/dl) in comparison to the level recorded at a week before parturition (70.83±1.30 mg/dl) and a week after parturition in ewes (63.91±1.18 mg/dl). It is apparent from the result that increasing trend in blood glucose level was found and the level was highest on the day of parturition. Increase in glucose level of parturition was also reported by several workers (Jacob and Vadodaria, 2001, El-Sherif and Assad, 2001 and Sireli *et al*., 2006) [5, 3, 10]. These findings were in contrast with the findings of Agrawal *et al.* (2007) [1] and Moghaddam *et al.* (2008) [8] in goats. But Anwar *et al.* (2012) [2] reported a sharp decline in serum glucose concentration from the day of parturition to the third day of lactation in three Egyptian sheep breeds, Barki, Rahmani and Barki x Rahmani crossbreed.

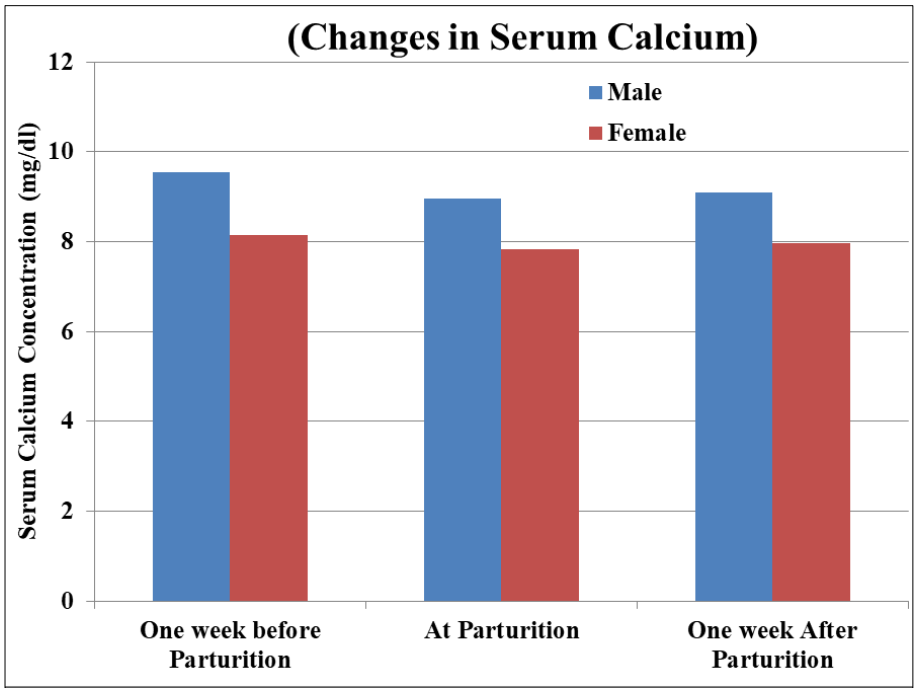

Fig 1: Changes in serum Calcium Concentration one week before parturition, at parturition and one week after parturition

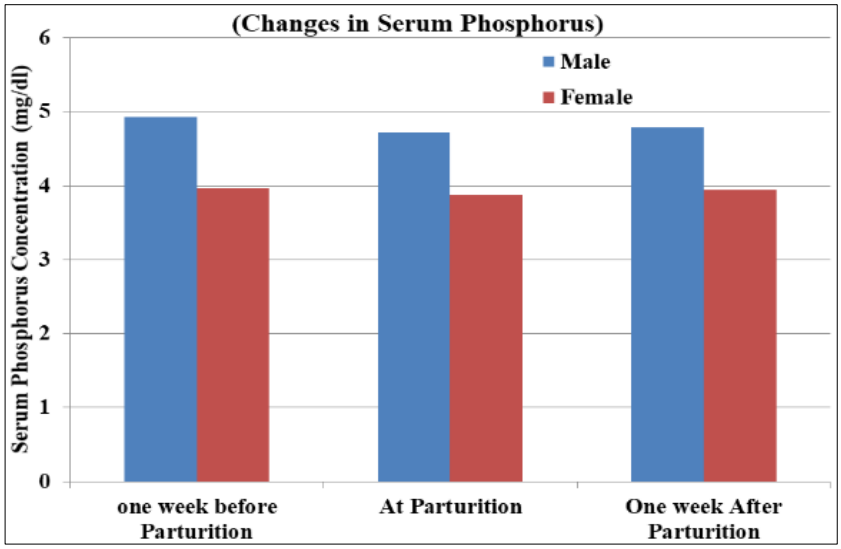

Fig 2: Changes in serum Phosphorus Concentration one week before parturition, at parturition and one week after parturition

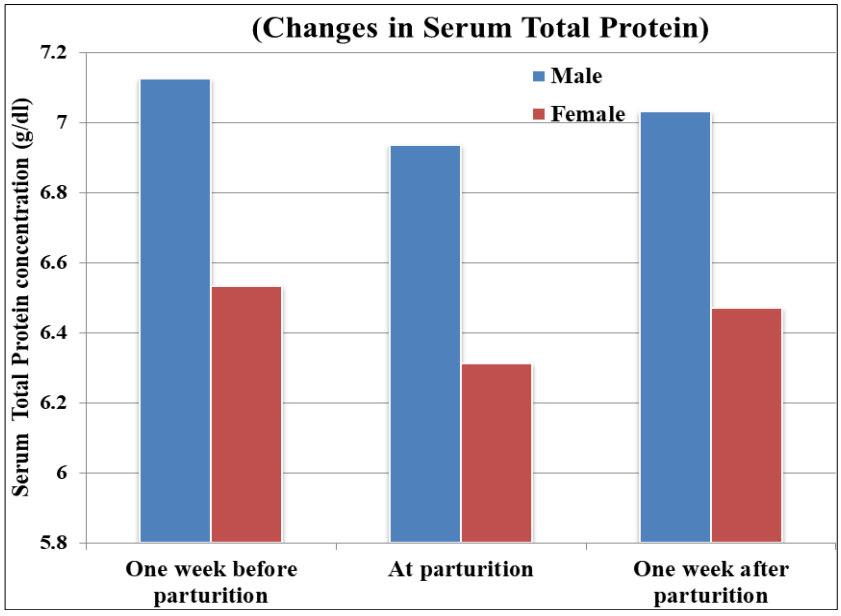

Fig 3: Changes in Serum total protein concentration in one week before parturition, at parturition and one week after parturition

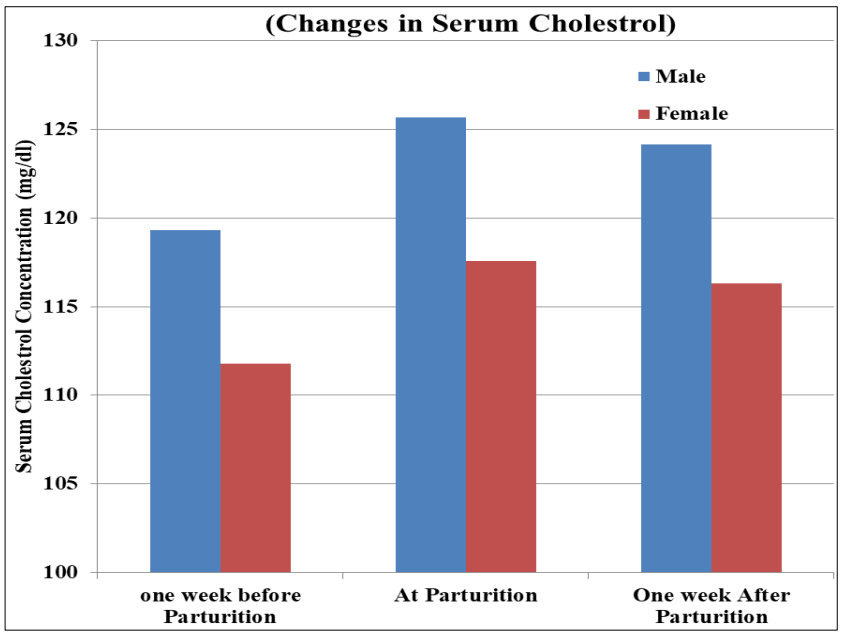

Fig 4: Changes in serum Cholestrol Concentration one week before parturition, at parturition and one week after parturition

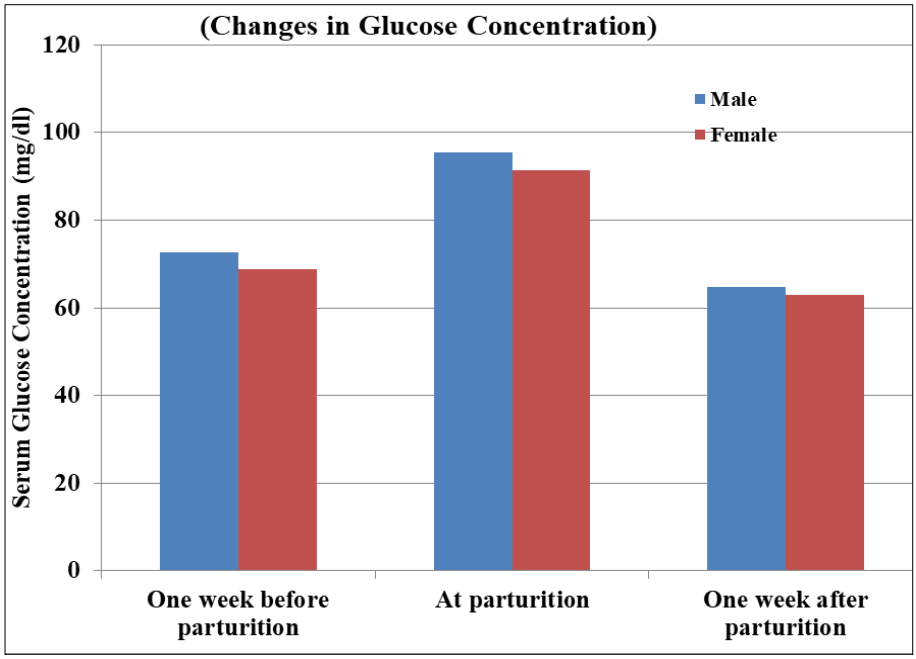

Fig 5: Changes in Glucose concentration in one week before parturition, at parturition and one week after parturition

Conclusion

In conclusion, the study tracked various hematological and biochemical parameters in ewes before, during, and after parturition. Results indicated significant fluctuations in these parameters, with notable increases observed in haemoglobin, erythrocyte, and leukocyte counts at parturition. Biochemical analyses revealed declines in serum calcium, total protein, and glucose levels post-partum, contrasting with elevated serum cholesterol. These findings provide valuable insights into the physiological changes accompanying lambing. Understanding these dynamics can inform better management practices to support ewe health and optimize reproductive outcomes in sheep farming. Further research is warranted to delve deeper into these metabolic and hematological shifts for enhanced sheep husbandry practices.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflict of Interest.

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