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Gautami Sarma
Department of Livestock Production Management, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Navin B Patel
Livestock Research Station, Navsari Agricultural University, Navsari, Gujarat, India

TKS Rao
Department of Livestock Production Management, Kamdhenu University, Navsari, Gujarat, India

Durgga Rani V
Department of Veterinary and Animal Husbandry Extension, Kamdhenu University, Navsari, Gujarat, India

Vipul Patel
Department of Animal Nutrition, Kamdhenu University, Navsari, Gujarat, India

Corresponding Author:
Gautami Sarma
Department of Livestock Production Management, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Production profile and haematobiochemical changes during the post-partum period in Surti goats

Gautami Sarma, Navin B Patel, TKS Rao, Durgga Rani V and Vipul Patel

Abstract
The present study was conducted on 16 Surti goats, divided into 2 groups: singlet and twin kids bearing after parturition to find out the difference in milk production and the changes in the hematobiochemical profile in postpartum Surti goats. The milk yield, fat and SNF % was recorded at weekly intervals i.e., on 7, 14, 21, 28, 35, 42, 49, 56 days of postpartum. Blood samples were collected on 0, 30 and 60 days of postpartum. Samples were analyzed for glucose, total protein, albumin, BUN, cholesterol and hematological parameters. Milk yield and MF% was significantly higher in twin kids bearing dams and SNF% was higher in singlet kid bearing dams. Significant (p<0.01) increasing pattern was observed in glucose, TP, albumin and BUN concentration from 0 to 60 days of parturition in both the groups. Hb level was lowest on the day of parturition and it showed an increasing pattern from 0 to 60 days. White Blood Cell (WBC) count and granulocyte % was significantly (p<0.01) higher in twin group and it showed a decreasing trend during postpartum period. Red blood cell (RBC), mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC) was observed showing decreasing pattern from 0 to 60 days of parturition. Increased milk production in twin kids bearing dams as compared to singlet kids bearing dams indicated better development of udder tissue in twin bearing dams. Initial low values of blood biochemicals and low levels of Hb, erythrocyte and hematocrit were indicative of stress during parturition. The increase in glucose might be due to recovery from negative energy.

Keywords: Hematobiochemical parameters, milk production, post-partum period, Surti goats

1. Introduction
Goats which are popularly known as “Poor man’s cow” due to its low cost of rearing and lesser management requirement, has served the mankind especially the rural poor farmers since prehistoric times. The versatile properties of its various products like milk, meat, hair and skin makes it a reliable and potential source of income. Surti goat which is mostly reared in the South Gujarat region of Western India is one of the best dual-purpose breed. Better milk yield and twinning ability makes it a breed of choice for rearing. Reproduction is an important phenomenon that determines the income of the livestock rearers.

Previous studies have suggested that postpartum constituents of blood and milk are important indicators of biochemical and physiological changes taking place during this critical period (Amer *et al.*, 1999; Manat *et al.*, 2016) [1, 10]. Ketosis and fatty liver condition were frequently reported to occur in the last stage of pregnancy (Sauvant *et al.*, 1991) [17]. The biochemical changes are related to the stress condition in animals which in turn is related to the productivity of the animals (Manat *et al.*, 2016; Soares *et al.*, 2018; Zamunar *et al.*, 2020) [10, 18, 22]. These changes vary with litter size (Madan *et al.*, 2020; Parretti *et al.*, 2001) [9, 12]. Haematological parameters also varied among breeds (Azab *et al.*, 1999; Manat *et al.*, 2016) [3, 10]. Milk yield was reported to be related to litter size (Hyden *et al.*, 1979; Zamunar *et al.*, 2020) [6, 22].

Limited studies have been reported regarding the milk production and blood biochemical attributes during the postpartum period which is a part of transition period in Surti goats. Accordingly, the study was undertaken to determine the production profile and changes in hematological and biochemical constituents after parturition.

2. Material and Methods
The study was carried out at the Livestock Research Station, Navsari Agricultural University, Navsari, on 16 Surti goats. Following parturition, the dams were divided into two groups, Group I, which contained 8 singlet kid-bearing goats, and Group II, which had 8 twin kid-

bearing goats. At least 7 days before the anticipated date of parturition, all of the animals were cared for and housed under the same management settings. There was soft straw bedding available. Goats were kept in a semi-loose housing system. The milk yield was recorded at weekly intervals i.e., on 7, 14, 21, 28, 35, 42, 49, 56 days of postpartum. The fat and SNF % was determined using Lactoscan milk analyzer. For viewing the haematobiochemical profile of the dam blood samples were collected K3 ethylenediaminetetraacetic acid vacutainers on the day of parturition/day of kidding (DOK), mid (30 days) and end (60 days) of experiment. Blood samples were used for estimation of glucose (BG), total protein (TP), albumin (ALB), blood urea nitrogen (BUN) and cholesterol using Erba kits on semi-automated clinical chemistry analyzer (Merck). Haematological parameters like white blood cell (WBC), lymphocyte, monocyte, granulocyte, hemoglobin (Hb), hematocrit (HCT), red blood cell (RBC), mean corpuscular hemoglobin (MCH), red cell distribution width (RDW), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC) was determined using fully automated hematology analyser (Exigo Vet).

The obtained data were first tabulated and means were calculated using descriptive statistics. Comparison between the groups was done using *t*-tests and mean within the group was compared using Duncan Multiple Range Test (DMRT) (Tallarida and Murray, 1987) [19].

3. Results

3.1 Milk yield and composition

Milk yield (MY), milk fat (MF) and solid not fat (SNF) content of milk have been presented in "Table 1". Higher MY was observed in twin kids bearing dams than singlet kid bearing dams on 7, 14, 21 ($p<0.01$) and 28 ($p<0.05$) days after parturition. The overall MY of twin kids bearing dams (0.991±0.04 ml) was also higher ($p<0.01$) as compared to singlet kid bearing dams (0.818±0.02 ml). F-value was highly significant in both the groups. While comparing within the group the MY showed an increasing pattern from 7 to 35 days of postpartum. In both the groups peak yield was observed between 4^{th}-5^{th} weeks of postpartum.

The mean value of MF % was higher ($p<0.05$) in twin kids bearing dams as compared to singlet bearing dams on 14, 28 and 35 days of postpartum. The overall MF % was also higher ($p<0.01$) in twin kids bearing dams (3.59±0.10 %) as compared to single kid bearing dams (3.11±0.07 %). While comparing within the group the MF % of both the groups showed a decreasing pattern from 7 to 28 days ($p<0.01$). Then it increased up to 42 days and thereafter it was similar up to 56 days.

SNF % was higher ($p<0.01$) in singlet group as compared to twin group on 28 days of postpartum. Significant ($p<0.01$) higher SNF % was observed in singlet bearing does ((8.43±0.02 %) than twin bearing does (8.28±0.03 %). F-value was highly significant in both the groups. While comparing within the group, it showed a decreasing trend from 7 to 21 days in both the groups. Then the values were similar from 21 to 56 days.

Table 1: Milk yield (MY), milk fat (MF) and Solid not fat (SNF) content of milk

MY (ml)	7 days	14 days	21 days	28 days	35 days	42 days	49 days	56 days	Overall	F-value
Singlet	0.487^{a}±0.02	0.612^{b}±0.03	0.800^{c}±0.04	0.950^{dc}±0.04	1.037^{e}±0.05	0.950^{de}±0.03	0.887^{cd}±0.02	0.800^{c}±0.02	0.818±0.02	21.780**
Twin	0.787^{a}±0.06	1.000^{bc}±0.06	1.100^{c}±0.07	1.162^{c}±0.07	1.125^{c}±0.04	0.987^{bc}±0.03	0.912^{ab}±0.02	0.850^{ab}±0.02	0.991±0.04	5.796**
t value	-3.984**	-5.057**	-3.464**	-2.347*	-1.251	-0.782	-0.599	-1.322	-3.480**	
MF (%)	7 days	14 days	21 days	28 days	35 days	42 days	49 days	56 days	Overall	F-value
Singlet	4.58^{d}±0.30	3.20^{bc}±0.19	2.73^{abc}±0.08	2.37^{a}±0.08	2.59^{ab}±0.08	3.33^{c}±0.19	3.00^{bc}±0.29	3.04^{bc}±0.19	3.11±0.07	11.245**
Twin	5.00^{d}±0.27	3.90^{c}±0.24	3.02^{ab}±0.14	2.62^{a}±0.08	3.36^{abc}±0.28	3.51^{bc}±0.31	3.77^{bc}±0.26	3.52^{bc}±0.19	3.59±0.10	8.551**
t-value	-1.014	-2.225*	-1.747	-2.110*	-2.602*	-0.497	-1.940	-1.743	-3.732**	-
SNF (%)	7 days	14 days	21 days	28 days	35 days	42 days	49 days	56 days	Overall	F-value
Singlet	9.26^{c}±0.16	8.75^{b}±0.11	8.27^{a}±0.07	8.24^{a}±0.06	8.07^{a}±0.07	8.28^{a}±0.10	8.30^{a}±0.05	8.26^{a}±0.05	8.43±0.02	16.602**
Twin	8.95^{c}±0.18	8.51^{b}±0.10	8.12^{a}±0.07	7.98^{a}±0.04	8.10^{a}±0.06	8.10^{a}±0.09	8.20^{a}±0.10	8.26^{ab}±0.06	8.28±0.03	10.555**
t-value	1.267	1.547	1.483	3.320**	-0.331	1.208	0.777	-0.042	3.304**	-

*&** indicates significance at $p<0.05$ and $p<0.01$ within column respectively and means bearing different superscript across rows differ significantly (*$p<0.05$, ** $p<0.01$).

3.2 Blood biochemical profile

The values of different biochemical parameters have been presented in "Table 2". Glucose concentration was higher in twin bearing dams as compared to singlet bearing dams on 0, 30 and 60 days postpartum but the difference was not significant. Minimum glucose concentration was observed on 0 day. The total protein did not show any significant difference between singlet and twin group however it was higher in twin group. Serum albumin concentration was significantly ($p<0.05$) higher on 60 days in twin bearing dams than singlet bearing dams. BUN was non-significantly higher in twin kids bearing dams as compared to single kid bearing dams on 0, 30 and 60 days of postpartum. The mean value of cholesterol was higher in twin group on 0 day, while it was higher in singlet group on 30 days and similar in both the groups on 60 days of postpartum. The overall cholesterol was higher for twin kids bearing does than single kid bearing does, however there was no significant difference on all the test days.

While comparing within the group significant ($p<0.01$) increasing pattern was observed in glucose, TP, albumin and BUN concentration from 0 to 60 days in both the groups.

Table 2: Mean ± S.E of Blood biochemicals in singlet and twin dams

Parameter	Day	Singlet (n=8)	Twin (n=8)	t value	Reference values
Glucose (mg/dl)	0 day	49.31^{a}±1.21	49.90^{a}±1.17	-0.350	62.8±7.1
	30 days	53.89^{b}±0.94	55.12^{b}±1.13	-0.833	(Kaneko *et al.*, 2008) [7]
	60 days	59.39^{c}±1.06	61.04^{c}±1.79	-0.791	
	Overall	54.19±0.96	55.35±1.01	-0.827	
	F-value	21.342**	15.446**	-	
Total Protein (g/dl)	0 day	5.62^{a}±0.28	4.95^{a}±0.17	2.020	6.9±4.8
	30 days	6.28^{ab}±0.47	6.43^{b}±0.33	-0.268	(Kaneko *et al.*, 2008) [7]
	60 days	7.33^{b}±0.31	7.97^{c}±0.44	-1.175	
	Overall	6.41±0.30	6.45±0.23	-0.113	
	F-value	5.476*	20.032**	-	
Albumin (g/dl)	0 day	2.65^{a}±0.22	2.88^{a}±0.23	-0.701	2.7-3.9
	30 days	3.57^{b}±0.13	3.91^{b}±0.18	-1.466	(Latimer, 2011) [8]
	60 days	4.19^{c}±0.09	4.60^{c}±0.15	-2.315*	
	Overall	3.47±0.10	3.80±0.17	-1.604	
	F-value	23.374**	20.231**	-	
BUN (mg/dl)	0 day	11.12^{a}±0.53	12.04^{a}±0.36	-1.424	10-20
	30 days	13.07^{b}±0.27	13.60^{b}±0.25	-1.438	(Latimer, 2011) [8]
	60 days	16.80^{c}±0.27	17.11^{c}±0.29	-0.782	
	Overall	13.66±0.29	14.25±0.22	-1.604	
	F-value	57.556**	70.830**	-	
Cholesterol (mg/dl)	0 day	113.17±4.89	142.17±17.99	-1.555	80-130
	30 days	129.87±17.63	121.09±18.14	0.346	(Latimer, 2011) [8]
	60 days	106.07±7.70	106.09±12.32	-0.001	
	Overall	116.37±8.22	123.12±11.47	-0.478	
	F-value	1.136	1.224	-	

*&** indicate significance at $p<0.05$ and $p<0.01$ respectively across rows and means bearing different superscript within column differ significantly ($p<0.05$).

3.3 Haematological profile

The hematological values of both the groups during post parturient period have been presented in "Table 3". The WBC count was significantly ($p<0.01$) higher in twin kids bearing dams than singlet kid bearing dams on 0 days and non-significantly higher on 30 and 60 days. The overall WBC count was significantly ($p<0.05$) higher in twin group than singlet group. Significant decreasing pattern in both singlet ($p<0.05$) and twin group ($p<0.01$) was observed from 0 to 60 days.

The lymphocyte % was significantly ($p<0.05$) higher in singlet group than twin group on 0 day. The overall lym % was higher in singlet bearing dams as compared to twin bearing dams but there was no significant difference. In twin group significant ($p<0.05$) increasing pattern from 0 to 60 days was noticed.

The overall mono % was higher in singlet group than twin group. But there was no significant difference on all the days. Within the group the values initially increased up to 30 days and then slightly decreased up to 60 days, but it was not significant.

The mean value of gran % was significantly ($p<0.01$) higher in twin bearing dams than single kid bearing dams on 0 day and 30 days. Twin group also had higher gran % on 60 days but it was not significant. The overall gran % was significantly ($p<0.01$) higher for twin group as compared to singlet group. Within the group there was no significant difference.

The Hb level was significantly higher in singlet bearing dams as compared to twin bearing dams on 0 day ($p<0.01$) and 30 days ($p<0.05$). The overall Hb was significantly ($p<0.05$) higher in singlet group than twin group. While comparing within the group the Hb concentration showed a significant ($p<0.01$) increasing trend from 0 to 30 days with lowest value on 0 day in both the groups.

No significant difference was seen in HCT % between singlet and twin group, however, significant ($p<0.01$) increasing from 0 to 30 days and decreasing pattern from 30 to 60 days was observed.

The RBC count was significantly higher in singlet group as compared to twin group on 0 day ($p<0.05$), 30 days ($p<0.05$) and 60 days ($p<0.01$). The overall RBC count was significantly ($p<0.01$) higher in singlet bearing dams than twin kids bearing dams. F-value was significant ($p<0.05$) for singlet group and highly significant ($p<0.01$) for twin group. Within the singlet group the values were similar for 0 and 30 days and between 0 and 60 days. While within twin group the values were similar for 0 and 30 days and it declined on 60 days of kidding.

No significant difference was seen in MCH between singlet and twin group, although it was higher in twin group on all test days. Significant ($p<0.01$) increasing pattern from 0 to 30 days and decreasing pattern from 30 to 60 days was observed.

The mean value of MCV was higher in twin kids bearing goats on 0, 30 and 60 days, but there was no significant difference on all the days. F-value was highly significant ($p<0.01$) for singlet group while it was significant ($p<0.05$) for twin group. In both the groups the values showed a decreasing pattern from 0 to 60 days of postpartum.

The mean value of MCHC was significantly ($p<0.05$) higher in twin group than singlet group on 30 days. It was also higher for singlet group on 0 day and 60 days, but the difference was not significant. The overall MCHC was higher in singlet group than twin group, but it was not significant.

Table 3: Mean ± S.E of hematological parameters in singlet and twin dams

Parameter	Day	Singlet (n=8)	Twin (n=8)	t value	Reference Values***
WBC (×10^3/µl)	0 day	11.68^b±0.54	15.05^b±0.70	-3.793**	3-13
	30 days	10.95^{ab}±0.58	12.36^a±1.15	-1.092	
	60 days	9.76^a±0.37	10.46^a±0.42	-1.231	
	Overall	10.79±0.42	12.62±0.65	-2.352*	
	F-value	3.652*	7.946**	-	
Lym (%)	0 day	50.71±0.85	45.48^a±2.20	2.209*	50-70
	30 days	52.08±1.18	50.10^{ab}±2.12	0.817	
	60 days	54.32±1.30	54.21 ^{b}±1.56	0.055	
	Overall	52.37±0.95	49.93±1.55	1.335	
	F-value	2.593	4.838*	-	
Mono (%)	0 day	6.70±0.27	6.70±0.30	2.181	0-4
	30 days	7.52±0.28	7.61±0.28	-0.217	
	60 days	7.47±0.24	7.03±0.33	1.060	
	Overall	7.23±0.25	7.11±0.22	0.340	
	F-value	3.033	2.237	-	
Gran (%)	0 day	38.15±1.23	43.51±1.37	-2.898**	30-48
	30 days	41.23±1.10	46.66±0.70	-4.132**	
	60 days	38.53±1.39	43.75±2.46	-1.843	
	Overall	39.31±0.99	44.64±1.08	-3.613**	
	F-value	3.033	1.093	-	
Hb (g/dl)	0 day	8.13^a±0.16	7.56^a±0.11	2.838**	8-12
	30 days	9.17^b±0.20	8.55^b±0.21	2.118*	
	60 days	9.65^b±0.13	9.08^b±0.25	1.973	
	Overall	8.98±0.15	8.40±0.17	2.496*	
	F-value	20.967**	14.509**	-	
HCT (%)	0 day	21.50^b±0.37	21.88^b±0.34	-0.760	22-38
	30 days	23.55^c±0.40	22.96^b±0.59	0.818	
	60 days	20.48^a±0.11	20.18^a±0.53	0.542	
	Overall	21.84±0.24	21.67±0.40	0.350	
	F-value	22.991**	7.700**	-	
RBC (×10^6/µl)	0 day	11.77^{ab}±0.15	11.21^b±0.17	2.427*	8-18
	30 days	12.58^b±0.44	11.53^b±0.17	2.192*	
	60 days	11.28^a±0.15	10.50^a±0.19	3.128**	
	Overall	11.88±0.22	11.08±0.14	3.024**	
	F-value	5.300*	8.072**	-	
MCH (pg)	0 day	6.86^a±0.16	7.05±0.26	-0.601	2.20-8
	30 days	7.35^b±0.13	7.50±0.14	-0.767	
	60 days	6.93^a±0.12	7.15±0.15	-1.097	
	Overall	7.05±0.12	7.23±0.14	-0.972	
	F-value	3.532**	1.466	-	
MCV (fl)	0 day	19.77^b±0.29	20.58^b±0.44	-1.521	16-25
	30 days	19.00^{ab}±0.34	19.57^{ab}±0.43	-1.032	
	60 days	18.12^a±0.25	18.86^a±0.35	-1.681	
	Overall	18.96±0.28	19.67±0.40	-1.437	
	F-value	7.527**	4.368*	-	
MCHC (g/dl)	0 day	38.10±0.37	37.17±0.34	1.816	30-36
	30 days	38.78±0.28	37.90±0.29	2.167*	
	60 days	38.20±0.34	38.01±0.28	0.418	
	Overall	38.36±0.30	37.69±0.27	1.607	
	F-value	1.216	2.161		

* & ** indicates significance at $p<0.5$ and $p<0.01$, respectively across rows and means bearing different superscript within column differ significantly ($p<0.05$), ***Feldman *et al.* (2002) [5].

4. Discussion

The present finding of increased MY in twin kids bearing dams was similar with the findings of Gamit *et al.* (2016) [23] which reported significantly higher MY on 7, 15 and 30 days and MF% on 7 and 15 days of postpartum in twin kids bearing Surti dams as compared to single kids bearing Surti dams. Hayden *et al.* (1979) [6] reported that placental lactogen affects the mammary gland differentiation during prepartum period and hence milk yield during lactation. Further, the study reported positive correlation between weight of lobulo-alveolar component and litter size. With increase in litter size significant ($p<0.05$) increase in milk yield was also reported by Zamuner *et al.* (2020) [22] which supported the present findings. Similar MF% and SNF% was reported in Mehsana goats by Patel and Pandey (2013) [24].

Glucose concentration was higher in twins due to increased demand from the foetus (Madan *et al.*, 2020; Parretti *et al.*, 2001) [9, 12]. Glucose concentration was reported to decrease from the day of kidding to 14 days of postpartum and then increased up to 45 days of postpartum. It was discussed to be due to metabolic changes and hormonal changes which induced gluconeogenesis and glycogenolysis (Sadjadian *et al.*, 2013; Soares *et al.*, 2018) [14, 18]. Glycemia during the first few weeks of lactation was attributed to high demand for milk

lactose synthesis specially, in high yielders and thereafter increase was because of the recovery from negative energy balance with proper feed intake (Manat *et al.*, 2016; Sadjadian *et al.*, 2013, Samardzija *et al.*, 2011) [10, 14, 15]. However, Amer *et al.* (1999) [1] reported negative correlation between serum glucose and milk lactose. At the end of pregnancy, the peripheral tissues' reduced reactivity to insulin causing the blood glucose levels to rise because these tissues conserve energy (Anwar *et al.*, 2012, Madan *et al.*, 2020) [2, 9]. Mbassa and Poulsen (1991) [11] reported glucose level was observed to be low during pregnancy than lactation in Danish Landrace goats.

The decrease in total cholesterol levels from day 0 to day 45 postpartum show that the animals used the lipids as a source of energy for milk production, and the high glucose level on day 0 shows that the animals were in a positive energy state (Madan *et al.*, 2020; Manat *et al.*, 2016) [9, 10]. Amer *et al.* (1999) [1] reported negative correlation between serum and milk cholesterol level which supported the present findings od decreasing cholesterol level. Zamunar *et al.* (2020) [22] observed that postpartum, high yielding goats had higher ratios of glucose, fatty acids, and BHB to insulin than did low yielding goats, which might explain the greater mobilization of body tissues and enhanced milk production observed in this group.

Madan *et al.* (2020) [9] reported a significant ($p \leq 0.05$) lower concentration of total protein and globulins was observed during late pregnancy and on the day of parturition, with a subsequent elevation during postpartum period (15 days and 30 days) which was in accordance with the present findings. Similar increase in TP was reported by (Tharwat *et al.*, 2013; Soares *et al.*, 2018; Anwar *et al.*, 2012; Elzein *et al.*, 2016 and Piccione *et al.*, 2011) [20, 18, 2, 4, 13]. The increase in total protein might be due to increase in immunoglobulin production (Manat *et al.*, 2016) [10]. Increase in albumin levels at postpartum period could be caused by to increase synthesis of albumin by the liver (Piccione *et al.*, 2011, Madan *et al.*, 2020) [13, 9].

The decrease in serum BUN around parturition was reported due to the decline in feed intake due to stress and hormonal changes during the kidding (Manat *et al.*, 2016) [10]. However, increase in BUN level during post parturient period was reported by Salem (2017) [16].

Blood picture revealed neutrophilia 1 week after kidding and monocytopenia +2 and +3 weeks postpartum. Erythrocyte and hematocrit value significantly ($p<0.01$) reduced after parturition (Tharwat *et al.*, 2013) [21]. Similar to the present results, a decrease in the level of MCH, MCV, MCHC, eosinophilia was reported during postpartum period in goats (Mbassa and Poulsen, 1991; Azab *et al.*, 1999) [11, 3]. Salem (2017) [16] noticed a significant reduction in RBCs, HB, and PCV% along with significant increase in MCV during post parturient period. Manat *et al.* (2016) [10] reported a similar finding of Hb concentration which was lowest on the day of kidding while was highest on 45 days of postpartum. This increase was discussed to be due to higher demand of oxygen and requirement of high metabolic rate during the postpartum period. Lym% was low on the day of parturition which might be due to low immunity or stress on the day of kidding. Decreasing trend was observed in gran % from 0 to 45 days of kidding. Granulocyte to lymphocyte ratio was observed to increase during the post-partum period which was explained to be due to stress that stimulates secretion of adrenocorticotropic hormone which in turn induces the adrenal cortex to produce glucocorticoids, involved in the mobilization of granulocytes from body pool into the peripheral circulation. The study reported significantly lower values of Hb, PCV, and TLC during first 2 weeks after parturition.

4. Conclusion

Milk production was higher in twin kids bearing dams as compared to singlet kids bearing dams. That might be due to better development of udder tissue in twin bearing dams. Some biochemical parameters showed significant changes between singlet and twin kids bearing goats during the postpartum period, although within the normal range. Increase in granulocytes and decrease in erythrocytic and hematocrit values were observed in the study. These changes in hematobiochemical parameters might be due to stress during parturition and in the postpartum phase. Learning about the impacts of twinning and changes during the postpartum time will be beneficial better management techniques for both dam and kids.

5. Acknowledgement

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