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Blood Biochemical Profile and Cortisol Level in Toggenberg Goat during Lactation

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ABSTRACT

The investigation was undertaken to study some blood biochemical parameters and cortisol levels during different stages in different lactations in Toggenberg goats. These included control group, consisting of dry goats and group I, II, III and IV containing goats in 1st, 2nd, 3rd and 4th lactation period. The total protein concentration showed an increasing trend from early to late lactation stages. There was an increasing levels of albumin in group I, II and IV and globulin in group II and III. Lowest total protein concentration was observed in third lactation (group III). Albumin and globulin ratio was higher in early lactation in group III (third lactation); whereas, in group II and IV, highest ratio was observed during mid lactation. Glucose concentration showed a definite increasing trend from early to late lactation stages in different lactations. Significantly lower ($P<0.05$) glucose levels were found in early as well as mid lactations as compared to late stage in all the four groups. Increasing trend of urea concentration was observed from early to late stage of lactation in all the lactating groups. The Total protein, globulin, glucose and urea levels were found higher in lactating goats as compared to dry animals. The cortisol level showed a decreasing trend from early to late stage of lactation, Again, the cortisol levels of lactating goats were significantly higher ($P<0.05$) than that of dry goats. Among different stages of lactation, early and mid stages are more stressful when compared to late stage.

Keywords: Biochemical parameters, cortisol, lactation, goat

Blood metabolic profile have been used widely to identify problem and to indicate dietary causes of diseases and low production (Lee, 1978) and considered important in evaluating the health status of animals. The estimation of various biochemical constituents like total protein, albumin, globulin, albumin globulin ratio, glucose and urea concentrations are the prerequisite to diagnosis several patho-physiological and metabolic disorders in cattles (Mc Dowell, 1992) and buffaloes (Hagawane *et al.*, 2009).

The postpartum or lactational period has been referred to as a period of stress hyporesponsiveness (Deschamps *et al.*, 2003; Slattery and Neumann, 2008). Lactation is high profile production phase and animals have to adjust their biological phenomena towards milk production system. It is noteworthy that hormones play lead role in physiological process of milk secretion and so, seasonal intervention of stress hormone in the milk secretion process is obvious during lactation. Since the milk constituents are basically derived from blood biochemical being secreted and synthesized in different metabolic pathways, therefore it is thought that studies on blood hormonal profile in such a vital stage of production would furnish valuable scientific information in relation to stage of lactation. So, the present experiment was planned to study some of the biochemical alterations according to different stages and different periods of lactation in Toggenberg goat.

MATERIALS AND METHODS

Total thirty number of Toggenberg goats were used in this study, divided into five groups of six goats each**.** These included control group which consisted of dry goats and Group I, Group II, Group III and Group IV containing goats in 1st, 2nd, 3rd and 4th lactation. The study was started in the month of February with the onset of lactation in goats and the blood samples were collected at one month interval in control as well as lactating goats. Further each

lactation period was divided into three stages namely early, mid and late stage. The samples collected in first two months were considered as early stage, 3rd and 4th months was considered as mid and 5th and 6th as late lactational stage. About 10 ml of blood was collected from each animal by venipuncture aseptically. 2 ml of blood was taken in sodium flouride vials for estimation of blood glucose. The rest of blood sample was allowed to clot and serum was separated and collected in storage vials and total protein, albumin and urea levels were estimated by commercially available standardized diagnostic kits. The globulin concentration of blood was estimated by subtracting the albumin concentration from total protein concentration. Cortisol level was estimated by immuno chemiluminiscence microparticle assay method using diagnostic products of IMMULITE diagnostic products corporation, Los Angles. All numerical data was processed using the statistical package for social science i.e. SPSS version 16.0 for windows. Analysis of variance (ANOVA) was done with the help of Tukey's test.

RESULTS AND DISCUSSION

Total protein, Albumin, Globulin and Albumin globulin ratio

In the present study (Table 1), it was found that total protein concentration was showing an increasing trend from early to late lactation stages in different lactations. This finding was comparable to those of Piccione *et al*. (2012), who observed gradual increase of total protein levels from early lactation (5.27±0.51gm/dl) to mid (6.28±0.65 gm/dl) and late lactation (6.38±0.46 gm/dl). Autonovic *et al*. (2011) also reported that the total protein concentration increased from 7.25±4.50 to 7.61±4.80 gm/dl from 20th to 60th day of lactation in Tsigai ewes. An increase in the level of total serum protein was observed with progress of lactation in the present study probably due to increased catabolism of protein associated with more milk synthesis as lactation advanced. Lower values in early lactation might be explained by a rapid extraction of immunoglobulin from the plasma during the last few months of pregnancy when colostrum is being formed in the mammary gland (Mohri *et al*., 2007; Kaneko *et al*., 2008). Regarding albumin and globulin levels, the present study (Table 1) depicted that increasing trend were observed in group I, II and IV for albumin and group II and III for globulin levels. Similar observation was also reported in ewes (Piccione *et al*., 2009) and dairy cows (Piccione *et al*., 2012). Autonovic *et al*. (2011) found that albumin level increased from 2.86±3.80 g/dl in lactating to 3.03±1.31 g/dl in non-pragnent ewes.

Total protein values were significantly (P<0.05) higher in lactating as compared to dry animals (Table 2). Albumin and globulin concentrations were higher in lactating than those of dry goats except albumin level in group II and III (Table 2). The higher values of concentrate to forage ratio provided during the lactation is generally associated with lower levels of fiber and higher level of starch in the diet, which gives rise to an increased production of propionic acid in the rumen and an increased microbial protein supply (Heck *et al*., 2009). Similar pattern of observation was also found in this study with an increased total serum protein level during lactations that decreased during the dry period. Increased total protein concentrations in lactation have been also reported in ewes (Fell *et al*., 1968) and rhesus monkey (Allen and Ahlgren, 1968). The higher total protein, albumin and globulin levels in lactating over dry period might be due to the low protein intake during dry period and due to dehydration (Yokus *et al*., 2006). Again, lowest total protein concentration was observed in third lactation (Table 2). Lower total protein concentration seen during the third lactation with the highest milk production as compared to the other three lactation periods might be due to more stress to the goats for enhanced milk production.

Albumin globulin ration was higher in dry animals when compared to lactating goats, might be due to increase in the level of acute phase proteins including globulins during the periods of metabolic stress e.g. lactation.

Blood glucose

Significantly lower (P<0.05) levels of glucose were found in early as well as mid lactations as compared to late stage in all the four groups (Table 1). Similarly, Hagawani *et al*. (2009) recorded the glucose levels in lactating buffaloes increased from early to mid lactation (37.54±3.44 mg/dl and 48.23±3.44 mg/dl, respectively). Lowered mean values of glucose concentration in early stage of lactation in all the groups could be due to large amount of blood glucose withdrawal by the mammary gland for the

Table 1: Blood biochemical parameters (Mean±S.E.) at different stages of lactation in Toggenberg goats

Parameters	Stages of Lactation / Groups (Lactation Number)	Early lactation	Mid lactation	Late lactation
Total Protein (gm/dl)	Control (n=12)	6.00±0.06	5.84±0.09	5.83±0.13
	Group I (n=12)	6.54 ^{a} ±0.09	7.08 ^{b} ±0.07	7.22 ^{b} ±0.09
	Group II (n=12)	6.63 ^{a} ±0.10	7.12 ^{b} ±0.10	7.36 ^{b} ±0.70
	Group III (n=12)	6.61 ^{a} ±0.06	6.81 ^{ab} ±0.05	6.91 ^{b} ±0.06
	Group IV (n=12)	6.81±0.09	7.00±0.11	7.13±0.12
Albumin (gm/dl)	Control (n=12)	3.46±0.05	3.40±0.04	3.45±0.05
	Group I (n=12)	3.48±0.14	4.04±0.16	4.14±0.17
	Group II (n=12)	2.23 ^{a} ±0.14	2.50 ^{b} ±0.12	2.55 ^{b} ±0.11
	Group III (n=12)	3.13 ^{a} ±0.50	2.57 ^{b} ±0.47	2.49 ^{b} ±0.34
	Group IV (n=12)	3.51±0.24	3.68±0.16	3.73±0.14
Globulin (gm/dl)	Control (n=12)	2.54±0.05	2.44±0.01	2.38±0.02
	Group I (n=12)	3.06±0.06	3.04±0.03	3.08±0.04
	Group II (n=12)	4.40 ^{a} ±0.13	4.62 ^{ab} ±0.66	4.81 ^{b} ±0.04
	Group III (n=12)	3.48 ^{a} ±0.02	4.24 ^{b} ±0.04	4.42 ^{b} ±0.02
	Group IV (n=12)	3.30±0.06	3.27±0.04	3.45±0.03
A:G	Control (n=12)	0.97±0.06	1.39±0.02	1.44±0.08
	Group I (n=12)	1.13±0.17	1.32±0.10	1.34±0.12
	Group II (n=12)	0.50±0.24	0.54±0.21	0.53±0.19
	Group III (n=12)	0.89±0.09	0.60±0.13	0.56±0.11
	Group IV (n=12)	1.06±0.14	1.14±0.15	1.06±0.18
Glucose (mg/dl)	Control (n=12)	54.13±0.61	52.93±0.20	53.93±0.20
	Group I (n=12)	53.60 ^{a} ±1.00	57.26 ^{a} ±0.96	68.55±1.20
	Group II (n=12)	49.99 ^{a} ±1.20	53.84 ^{a} ±1.72	63.49±1.81
	Group III (n=12)	47.96 ^{a} ±0.28	51.24 ^{a} ±0.86	60.70±1.81
	Group IV (n=12)	51.72 ^{a} ±1.08	55.39 ^{a} ±1.55	62.33±1.6
Urea (mg/dl)	Control (n=12)	12.20±0.18	12.23±0.20	13.15±0.27
	Group I (n=12)	15.50 ^{a} ±0.45	16.34 ^{a} ±0.48	21.53 ^{b} ±0.53
	Group II (n=12)	15.03 ^{a} ±0.62	16.15 ^{a} ±0.45	22.40 ^{b} ±0.45
	Group III (n=12)	16.49 ^{a} ±0.55	18.57 ^{b} ±0.47	23.95 ^{c} ±0.45
	Group IV (n=12)	14.38 ^{a} ±0.30	16.87 ^{b} ±0.18	23.12 ^{c} ±0.36

Mean with different superscript in the row differ significantly ($P<0.05$)

synthesis of milk lactose (Schultz, 1968). Again, it was found in earlier studies that high level of epinephrine stimulated blood glucose level in early phase of lactation (Chavez *et al*., 2009), due to glycogenolytic effect of the hormone on the liver and this hypothesis can be related to the earlier findings of Baird (1979) who reported that liver reserve of glycogen are lowest during the early lactation. Again in another study, Carcangiu *et al*. (2008) found that plasma concentration of glucose in ewes were higher in first week (68.8±8.6 mg/dl) as compared to the fourth week of lactation (60.1±8.2 mg/dl).

Except third lactation (group III), higher glucose level was observed in lactating as compared to dry goats (Table 2). Current findings was consistent with earlier findings of

Table 2: Blood biochemical parameters (Mean±S.E) during different lactations in Toggenberg goats

Parameters	Control (n=36)	Group I (1st lactation) (n=36)	Group II (2nd lactation) (n=36)	Group III (3rd lactation) (n=36)	Group IV (4th lactation) (n=36)
Total Protein (gm/dl)	5.89 ^{b} ±0.05	6.95 ^{a} ±0.07	7.04 ^{a} ±0.07	6.77 ^{a} ±0.03	6.98 ^{a} ±0.06
Albumin (gm/dl)	3.43 ^{b} ±0.02	3.88 ^{b} ±0.09	2.42 ^{a} ±0.07	2.73 ^{a} ±0.03	3.64 ^{b} ±0.99
Globulin (gm/dl)	2.45 ^{a} ±0.01	3.06±0.02	4.61 ^{b} ±0.05	4.04 ^{b} ±0.02	3.34 ^{c} ±0.02
A:G	1.26±0.04	1.26±0.07	0.52±0.12	0.68±0.07	1.08±0.09
Glucose (mg/dl)	53.66 ^{b} ±0.02	59.78 ^{a} ±1.20	55.77 ^{ab} ±1.31	53.30 ^{b} ±1.14	56.48 ^{ab} ±1.10
Urea (mg/dl)	12.52 ^{a} ±0.14	17.00 ^{b} ±0.60	17.89 ^{b} ±0.62	19.67 ^{b} ±0.59	18.29 ^{b} ±0.61

Mean with different superscript in the row differ significantly (P<0.05)

Kudlac *et al.* (1988) and Zvorc *et al.* (2006) who reported that glucose delivery and uptake by the mammary gland are a rate limiting step of milk synthesis. It is thought that insulin independent glucose uptake decreases in tissue, except in mammary gland, and insulin resistance in the whole body increases following the onset of lactation (Komatsu *et al.*, 2005). In contrast to our current finding, other findings revealed lower glucose levels in lactating ewes (Roubies *et al.*, 2006; Autonovic *et al.*, 2011), lactating sows (Tumbleson *et al.*, 1970), lactating mares (Heidler *et al.*, 2002) and lactating buffaloes (Hagawane *et al.*, 2009). However, in our study, lowest glucose concentration (53.30±1.14 mg/dl) was observed in third lactation (group III). High lactation yield during third lactation might leads to imbalance in blood glucose homeostasis (Pambu Gollah *et al.*, 2000), as constant energy required for synthesis of milk lactose.

Urea

In this study (Table 1) it was observed that the values showed a definite trend of increase in urea concentration from early to late lactation period in different lactations. Significantly higher (P<0.05) urea concentration (mg/dl) were recorded at late lactation in group I and II; whereas in group III and IV urea concentrations were significantly higher (P<0.05) at both mid and late lactations as compared to early stage. In dry animals (control group) the values were statistically non-significant and ranged between 12.20±0.18 to 13.15±0.27 mg/dl.

In this study, the increasing trend of urea concentration observed from early to late stage of lactation in all the lactating groups support the hypothesis that changes in blood urea content during lactation could depend on milk synthesis (El-Sherif and Assad, 2001). Hagawane *et al.* (2009) also reported lowest average value (17.93±0.79 mg/dl) in early lactation as compared to mid (19.72±1.50mg/dl) and late lactation (25.09±0.80 mg/dl) in buffaloes. In contrast, Zumboo *et al.* (2007) reported higher urea concentration in mid lactation as compared to early and late stages during second and forth lactations in goats. Zvonko *et al.* (2011) also found that urea concentration increased from 6.80±0.46 to 7.43±0.59 mmol/l from 20th to 60th day of lactation in Tsigai ewes, which further confirms the present study.

Significantly higher (P<0.05) urea concentration (mg/dl) was observed during lactation period as compared to dry Toggenberg goats, recorded as 17.00±0.60, 17.89±0.62, 19.67±0.59 and 18.29±0.61 in group I and II, III and IV

Table 3: Cortisol level (Mean± S.E.) during different stages of lactation in Toggenberg goats

Parameter	Stages of Lactation Number. (Groups)	Early lactation	Mid lactation	Late lactation
Cortisol (ng/ml)	Control (n=12)	4.77±0.13	5.02±0.04	5.22±0.15
	Group I (n=12)	9.73 [a] ±0.12	7.64 [b] ±0.11	4.66 [c] ±0.13
	Group II (n=12)	9.88 [a] ±0.17	6.81 [b] ±0.19	4.53 [c] ±0.13
	Group III (n=12)	10.23 [a] ±0.45	6.98 [b] ±0.51	6.78 [c] ±0.37
	Group IV (n=12)	9.93±0.18[a]	7.15±0.15[b]	4.33±0.12[c]

Mean with different superscript in the row differ significantly (P<0.05)

Table 4: Cortisol level (Mean± S.E.) during different lactations in Toggenberg goats

Parameter	Control (n=36)	Group I (1st lactation) (n=36)	Group II (2nd lactation) (n=36)	Group III (3rd lactation) (n=36)	Group IV (4th lactation) (n=36)
Cortisol (ng/ml)	5.05 [b] ±0.07	7.34 [a] ±0.35	7.07 [a] ±0.38	7.99 [a] ±0.39	7.14 [a] ±0.39

Mean with different superscript in the row differ significantly (P<0.05)

and 12.52±0.14 in control animals (Table 2). Greater urea concentration in lactating goats might be due to increasing catabolism of muscle protein during lactation, when large amounts of body reserves are mobilized. Autonovic *et al*. (2011) also found higher urea level in lactating (6.80±0.46 mmol/l) as compared to non-pregnant dry goats (6.02±0.52 mmol/l).

This finding in Toggenberg goats was in accordance with the report in other studies in sheep and goats (Doornenbal *et al.*, 1988; Karapehlivan *et al*., 2007). Lower level of urea in dry animals also recorded in Tuj (Karapehlivan *et al*., 2007) and Sakiz-Awassi crossbreds ewes (Yokus *et al*., 2006).

Cortisol

It was found in the present experiment that the cortisol levels showed a decreasing trend from early to late stage of lactation (Table 3). The highest value observed at early lactation, followed by higher values at mid lactation and lowest values at late lactation in group I, II, III & IV, respectively. In dry animals (control group) the values ranged between 4.77±0.13 to 5.22±0.15 ng/ml. Other workers (Khan and Ludri 2002, Suganya and Gomathy 2009) found that the cortisol levels remain high around kidding days.

Table 4 depicted that cortisol level (ng/ml) was significantly higher (P<0.05) during lactation period (group I, II III & IV) as compared to dry Toggenberg goats. The values (ng/ml) ranged between 7.07±0.38 to 7.99±0.39 in lactating and 5.05±0.07 in control (dry) animals. Lactational period has been referred to as a period of stress hyporesponsiveness (Deschamps *et al*., 2003; Slattery and Neumann, 2008). In our finding also it was found that the level of stress hormone i.e. cortisol levels of lactating goats were significantly higher (P<0.05) than that of dry goats. Similar type of stress responses during lactation have been also reported in some other animal population (Tumt and Walker, 2005, Brunton *et al*., 2008). Other studies, however, revealed similar cortisol level in lactating and dry goats (Alvarez and Galindo, 2008).

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