Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2021; 9(1): 1887-1895

Received: 04-10-2020
Accepted: 06-12-2020

Asha Lata Murmu
M.V.Sc. Scholar, Department of Vety. Physiology, R.V.C., Ranchi, Jharkhand, India

RK Verma
Assistant Professor, Department of Vety. Physiology, R.V.C., Ranchi, Jharkhand, India

Shiv Kumar Yadav
Assistant Professor-cum-Junior Scientist, Department of Vety. Biochemistry, R.V.C., Ranchi, Jharkhand, India

Sasmita Barik
Assistant Professor-cum-Junior Scientist, Department of Vety. Biochemistry, R.V.C., Ranchi, Jharkhand, India

SK Maurya
Assistant Professor, Department of Vety. Biochemistry, CVSc & AH, Kumarganj, Ayodhya, Uttar Pradesh, India

Sanjay Kumar
Scientist (A. H), KVK, Dumka, Jharkhand, India

Corresponding Author:
RK Verma
Assistant Professor, Department of Vety. Physiology, R.V.C., Ranchi, Jharkhand, India

Effects of different meteorological variables on blood biochemical parametersin black Bengal goats

Asha Lata Murmu, RK Verma, Shiv Kumar Yadav, Sasmita Barik, SK Maurya and Sanjay Kumar

DOI: https://doi.org/10.22271/j.ento.2021.v9.i1aa.8407

Abstract
Despite having well-developed mechanisms of thermoregulation, animals do not maintain strict homeothermy under extreme climatic conditions. As a result, animals develop various adaptive mechanisms that enable them to survive under those conditions of extreme heat or extreme cold. The study was conducted on twelve healthy Black Bengal Goats to determine the effect of seasonal variations on biochemical profiles during autumn and winter. Blood samples collected from the jugular vein at fortnightly interval used for biochemical analysis. Among the biochemical constituents the mean concentration of glucose (mg/dl) was found to be significantly (p<0.05) higher during winter than the autumn season and observed to be inversely proportional to the THI. The estimated serum total protein non-significantly differed and was directly proportional to the THI. The serum mineral profile studied in Black Bengal Goat showed significant (p<0.05) variation in between the seasons. The serum calcium (mg/dl), inorganic phosphorous (mg/dl) and magnesium level were significantly (p<0.05) lowered during winter than autumn and were found to be directly proportional to the THI. The study revealed that some of the parameters studied were visibly drifted from normal values as a result of climate stress during the winter season.

Keywords: temperature humidity index, dry bulb temperature, wet bulb temperature, total serum protein

1. Introduction
In the present era, climate change is the most concerned and critical challenge that both human and animals were facing. Food, nutrition and environmental security in the new millennium are challenging job for the agricultural scientists. Alteration in temperature, rain, wind, radiation etc have a definite impact on the productivity of animals and hence implying the concerned food security also. Goats (*Capra hircus*) are the earliest animals to be domesticated for meat and milk purpose and are generally labeled as a "poor man's cow ″and as a 'wet nurse' of infants in Europe (Mac Hugh and Bradley, 2001) [21]. Common breeds of goats found in India are Jamunapari, Marwari, Kutchi, Surti, Gohilwadi, Barbari, Gaddi, Chegu, Sirohi, Osmanabadi, Black Bengal, Beetal, Zalawadi, Mehsani. Among these, Black Bengal goats are found throughout West Bengal, Jharkhand, Bihar and Orissa regions of north eastern India. It has the specific feature of strong adaptability to various adverse socio-economic situation of the rural India and arid tropics because of its ability to conserve water, travel well, graze selectively and take willingly a wide variety of vegetation (Meferlane and Howard, 1972; Maloity and Taylor 1971; Merrill *et al.*, 1965) [23, 22, 24]. Goats adapt poorly to cold climates but make them relatively more adapted to areas of high temperatures (Shelton and spiller, 1977) [33]. Adaptation of animals for ecological stresscan affect serum biochemistry of livestock animals (Swanson *et al.*, 2004; Nazifi *et al.*, 2003) [36, 27]. Serum biochemical analysis constitute important panels in the diagnosis, prognosis and treatment of livestock diseases (Yokus *et al.*, 2006) [39]. The seasonal rythms reflect the endogenous adaptive mechanism to react in advance to the regular environmental changes associated with the seasons (Piccione *et al.*, 2009) [29]. Limited information is provided about the seasonal rythms of small ruminants like Goats in tropical climate (Piccione *et al.*, 2009; Alila-Johansson *et al.*, 2001, 2004) [29, 3].
Minerals also play an important role in increasing efficiency of livestock production and reproduction as they act as catalysts in the enzymes and hormonal systems of the body (Ceylan

et al., 2008) [7]. Disturbances in one or more minerals lead to a cascade of events that alter the hormonal milieu along the H-P-O axis and ultimately lead to a disturbance in reproductive functions (Kumar *et al.*, 2007) [19]. Metallo-enzymes of which essential minerals are constituents, are important in the synthesis of many steroid hormones and thyroid hormones (Suttle, 2010) [35]. For such consideration the study aimed to evaluate the serum content of electrolytes in goat. Variations in hormone bioactivity allow the animals to adapt their metabolic balance to different environmental conditions. The neuro-humoral system has a seasonal pattern in controlling the blood metabolites (Chaffee and Roberts, 1971) [8]. Effect of climatic variation on biochemical parameters has not been studied in Black Bengal Goats. So the present project was designed to study the effect of seasonal variation on biochemical parameters of Black Bengal Goats.

2. Material Methods

2.1 Selection of experimental animal

Healthy, Black Bengal does n=12, having an approximately average body weight of 8 to 14 kg and age 8-24 months, reared under uniform managemental husbandry practices were selected from, Instructional Farm of Small Ruminants (I.F.S.R.), College of Veterinary Science and A.H. Birsa Agricultural University, Kanke, Ranchi (BAU) in the period from 2018 (October)-19 (January) for the present experiment. Selected does were isolated from the herd at least fifteen days before the start of the experiment.

2.2 Maintainance of experimental animal

The does were allowed routine grazing (daily for four to six hours) and feeding with balanced ration (Maize 42.25%, Wheat bran 37%, GNC 18.5%, Mineral mixture 2%, Common salt 0.25%, NRC 1980) at the rate of 250 gm/animal/day with *ad- libitum* water. The animals were dewormed with anthelmintic Fembendazole @ 10mg/kg of body weight 15 days before the start of experiment. The selected twelve animals were maintained at normal animal husbandry practices. The experiments were conducted during two seasons i.e., autumn (Oct-Nov) and winter (Dec- Jan).

2.3 Blood Sampling

The blood sample with anticoagulant in EDTA vials was collected from the jugular vein of each animal on 0^{th}day and every 15^{th} day up to 120 days for biochemical examination. The blood samples in serum vial were allowed to clot at room temperature in centrifuge tubes for 2-3 hours. The serum was pipette off, centrifuged at 3000 rpm for 10 minutes and stored at -20ºC for further analysis of biochemical parameters.

2.4 Meteorological Parameter:

Climatic variables *viz* temperature, relative humidity was recorded. Temperature humidity index was calculated as per Johnson formula (1972) i.e., THI = 0.72 (DBT+WBT) + 40.6 (Where, THI= Temperature humidity index, DBT Dry bulb temperature, WBT=Wetbulb temperature)

2.5 Blood Biochemical Parameters:

The following biochemical parameters were recorded in all animals at 0^{th}day and every 15^{th} day up to 120 days as per the described methods.

2.5.1. Total Serum Protein:

Total serum protein was estimated by Biuret Method as described by Gornall *et al.* (1949) [15]. Tulip diagnostic kit was used for the estimation of Total serum protein. As proteins, in an alkaline medium, bind with the cupric ions present in the biuret reagent to form a blue-violet coloured complex. The intensity of the colour is directly proportional to the amount of proteins present in the sample.

Protocol: To 1ml of biuret reagent, 0.02 ml each of standard (S), test sample (T) and distilled water (B) were added in three separate test tubes. The contents were mixed thoroughly and incubate at 37ºC for 10 minutes. The absorbance of standard (S) and test samples (T), against the blank (B) was measured on spectrophotometer at 550 nm. The total serum protein concentration was calculated by using the formula:

Total serum protein (g/dl) = $\left(\frac{Abs.T}{Abs.T}\right)\times$ 8 where, abs. T = Absorbance of test and abs. S = absorbance of standard.

2.5.2 Serum glucose

Serum glucose was determined by GOD/POD method as described by Trinder (1969) [37]. Tulip diagnostic kit was used for the estimation of serum glucose.Glucose in serum is oxidized to gluconic acid and hydrogen peroxide in the presence of glucose oxidase. Produced hydrogen peroxide further reacts with phenol and 4- aminoantipyrine by peroxidase to form a red coloured quinoneimine complex. Intensity of the colour formed is directly proportional to the amount of glucose present in the sample.

Protocol: To 1 ml of glucose Reagent (L1), 0.01 ml each of standard (S), test sample (T) and distilled water (B) were added in three separate test tubes. The contents were mixed thoroughly and incubate at 37ºC for 10 minutes. The absorbance of the Standard (S) and Test Sample (T), against Blank (B) were measured on spectrophotometer at 505 nm. The serum glucose concentration was calculated by using the following formula:

Total glucose (mg/dl) = $\left(\frac{Abs.T}{Abs.T}\right)\times 100$, where, abs. T = Absorbance of test and abs. S = Absorbance of standard.

2.5.3 Serum Calcium

Serum calcium was estimated by OCPC method as described by Bagainski (1973) [4]. Tulipdiagnostic kit was used for the estimation of serum calcium. Calcium in an alkaline medium combines with O-cresolphthalein complexone to form a purple-coloured complex. Intensity of the colour formed is directly proportional to the amount of calcium present in the sample.

Protocol: To 0.5 ml of buffer reagent (L1), 0.5 ml of colour Reagent (L2) followed by 0.02 ml each of standard (S), test sample (T) and distilled water (B) were added in three separate test tubes. The contents were mixed thoroughly and incubated at room temperature (25ºC) for 5 mins. The absorbance of the standard (S) and test Sample (T) against, blank (B) was measured on spectrophotometer at 570 nm. The serum calcium concentration was calculated by using the following formula:

Total calcium (mg/dl) =$\left(\frac{Abs.T}{Abs.S}\right)\times 10$, where, abs. T = Absorbance of test and abs. S = Absorbance of standard.

2.5.4 Serum Inorganic Phosphorus

Serum phosphorus was measured by molybdate U.V. method as described by Goodwin (1970) [14]. Tulip diagnostic kit was used for the estimation of serum phosphorus. Phosphate ions in an acidic medium react with ammonium Molybdate to form a phosphomolybdate complex. This complex has an absorbance in the ultraviolet range and is measured at 340 nm. Intensity of the complex formed is directly proportional to the amount of inorganic phosphorus present in the sample.

Protocol: To 1.0 ml of Working reagent, 0.02 ml each of standard (S), test sample (T) and distilled water (B) were added in three separate test tubes. The contents were mixed thoroughly and incubated at room temperature (25ºC) for 5 mins. The absorbance of the Standard (S) and Test Sample (T), against the Blank (B) was measured on spectrophotometer at 340 nm. The serum phosphorus concentration was calculated by using the following formula:

Phosphorus (mg/dl) = $\left(\frac{Abs.T}{Abs.S}\right) \times 5$ where, abs. T = Absorbance of test and abs. S = Absorbance of standard.

2.5.5 Serum Magnesium:

Serum magnesium was estimated by Calmagite method as described by Gindler *et al.* (1971) [13]. Tulip diagnostic kit was used for the estimation of serum magnesium. Magnesium combines with calmagite in an alkaline medium to form a red coloured complex. Interference of calcium and proteins is eliminated by the addition of specific chelating agents and detergents. Intensity of the colour formed is directly proportional to the amount of magnesium present in the sample.

Protocol: To 0.5 ml of buffer Reagent (L1), 0.5 ml of colour reagent (L2) added, followed by addition of 0.01 ml each of standard (S), test sample (T) and distilled water (B) in three separate test tubes. The contents were mixed thoroughly and incubated at room temperature (25ºC) for 5 mins. The absorbance of the standard (S) and Test Sample (T), against Blank (B) was measured on spectrophotometer at 340 nm. The serum magnesium concentration was calculated by using the following formula

Magnesium in (mEq/L) = $\left(\frac{Abs.T}{Abs.S}\right) \times 2$, where, abs. T = Absorbance of test and abs. S = Absorbance of standard. (Note: - 1mEq/L = 0.5 mmol = 2.44 mg/dl)

3. Result and Discussion

3.1 Meteorological parameters

Climatic changes have a range of impacts on the physical, mental & community health of animals. Data of temperature and humidity of shades in which animals were kept were recorded daily with help of a dry bulb thermometer. The present experiment was conducted to study the effect of meteorological variables on biochemical parameters in Black Bengal Goat.

3.1.1 Ambient temperature (ºC)

As observed from Table 1, mean ambient temperature in autumn recorded 15th day interval was 17.27±0.40, 15.29±0.53, 16.43±1.07 and 10.74±1.03 on 15th, 30th, 45th and 60th day respectively. The mean ambient temperature was found to be significantly lower ($p<0.01$) on day 60th during autumn. Similarly, during the winter, the mean ambient temperature recorded on 15th day was found to be significantly ($p<0.01$) higher as compared to that was on day 30th and 45th. The mean ambient temperature was found to be 6.91±0.62, 3.55±0.60, 3.89±0.40 and 5.16±0.88 on 15thday, 30th, 45th and 60th respectively (Table 1, Fig 1). Within row, the difference between the temperature of autumn & winter were compared using independent t-test and was found to be highly significant for 15th, 30th, 45th and 60th day respectively. But the mean temperature in autumn was greater than winter at all four periodical intervals. The following table-1 shows the ambient temperature of autumn & winter as recorded at 15th day intervals at different periods for the shades of experimental animals.

Table 1: Ambient temperature (ºC) of autumn and winter season at different periods (Mean ±SE).

Days	Autumn	Winter	T value (P critical)
15th day	17.27±0.40^{b}	6.91±0.62^{b}	7.00**
30th day	15.29±0.53^{b}	3.55±0.60^{a}	7.74**
45th day	16.43±1.07^{b}	3.89±0.40^{a}	3.00**
60th day	10.74±1.03^{a}	5.16±0.88^{ab}	0.009**
F value	12.79**	5.53**	

NS - $P \geq 0.05$; *$P<0.05$ - Significant; **$P<0.01$- Highly Significant.

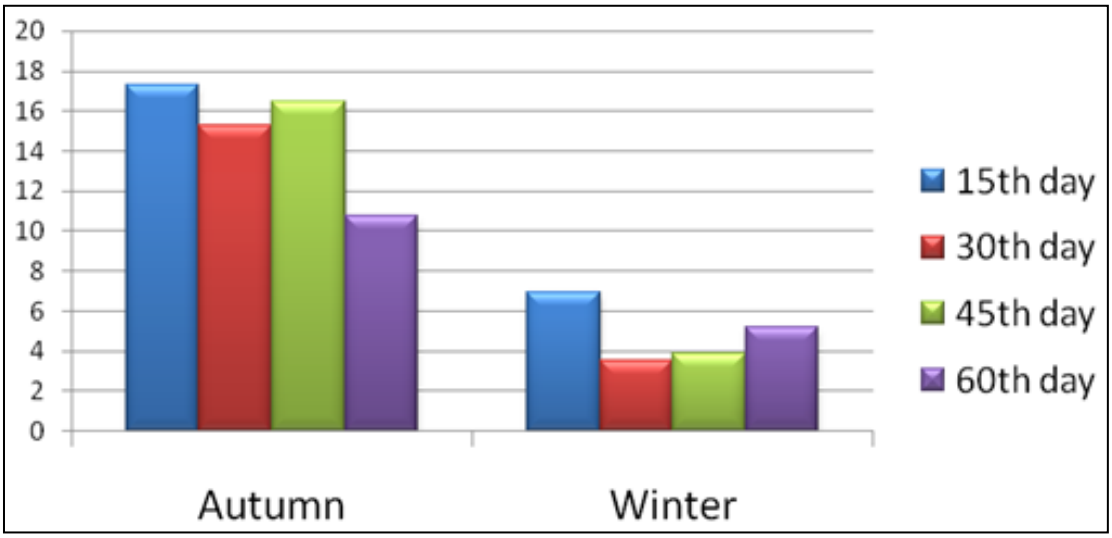

Fig 1: Bar diagram depicting the ambient temperature (ºc) of autumn and winter season at different periods (Mean ±SE).

3.1.2 Relative humidity (%)

Table-2 suggests that the difference between Relative humidity was non-significant between autumn and winter at all the fortnights except for that on day 15th the t-value (p critical) in that case was 0.04 (p<0.05) and thus the relative humidity was significantly higher in autumn (69±0.33) than in winter (66.4±1.22). Relative humidity on 15th, 30th, 45th and 60th day in Autumn was observed to be 69±0.33, 70.06±1.29, 66.4±2.43, and 65.26±1.76 respectively, while during winter, the relative humidity was found to be 66.4±1.22, 66.73±1.65, 67.8±0.50 and 67.53±0.74 on 15th, 30th, 45th and 60th day respectively. In our finding the average relative humidity was higher than the findings of Rathwa *et al*. (2017) [31], may because of heavy rainfall in this region.

Table 2: Relative humidity (%) of autumn and winter season at different periods (Mean±SE).

Days	Autumn	Winter	t value (P critical)
15th day	69±0.33	66.4±1.22	0.04*
30th day	70.06±1.29	66.73±1.65	0.12^{NS}
45th day	66.4±2.43	67.8±0.50	0.56^{NS}
60th day	65.26±1.76	67.53±0.74	0.28^{NS}
F value	1.83^{NS}	0.34^{NS}	

NS - P≥0.05; *P<0.05 - Significant; **P<0.01- Highly Significant

.

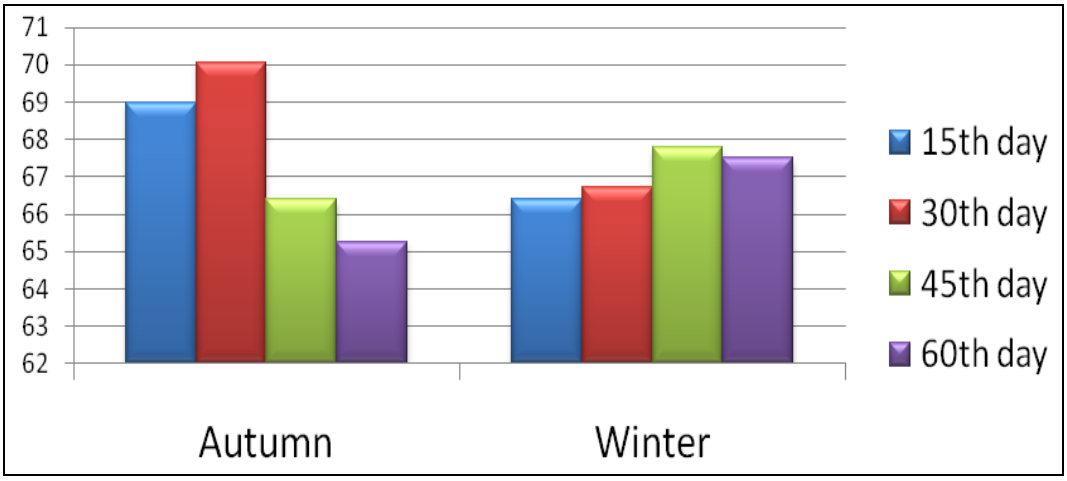

Fig 2: Bar diagram depicting Relative humidity (%) of Autumn and Winter season at different periods (Mean±SE).

3.1.3 Temperature humidity index

Temperature humidity index of autumn and winter season at different fortnights have been tabulated (Table3). The mean THI value has been found to be 72.48±0.45, 70.45±0.60, 72.73±1.23 and 66.64±0.97 for 15th, 30th, 45th and 60th day respectively. The F value of 10.54 (P<0.01) was highly significant indicating significant variation in THI value at periodical interval. Further the F value of 11.29 was highly significant (P<0.01) between the THI as recorded at fortnightly intervals during the winter season. The highest mean THI value was 63.87±0.56 as recorded at 15th day of winter followed by mean value of 57.58±0.91, 58.29±0.68 and 60.89±1.13 at 30th, 45th and 60th day respectively. The difference between THI value of autumn and winter was found to be highly significant (P<0.01) at 15th, 30th, 45th day intervals and significant (P<0.05) at 60th day interval. Although the THI value of autumn was higher than winter at all the four fortnightly intervals.

Table 3: Temperature humidity index of autumn and winter season at different periods (Mean±SE).

Days	Autumn	Winter	t value (P critical)
15th day	$72.48±0.45^{b}$	$63.87±0.56^{c}$	0.00^{**}
30th day	$70.45±0.60^{b}$	$57.58±0.91^{a}$	0.00^{**}
45th day	$72.73±1.23^{b}$	$58.29±0.68^{a}$	0.00^{**}
60th day	$66.64±0.97^{a}$	$60.89±1.13^{b}$	0.01*
F value	10.54**	11.29**	

NS – P≥0.05; *P<0.05 – Significant; **P<0.01- Highly Significant.

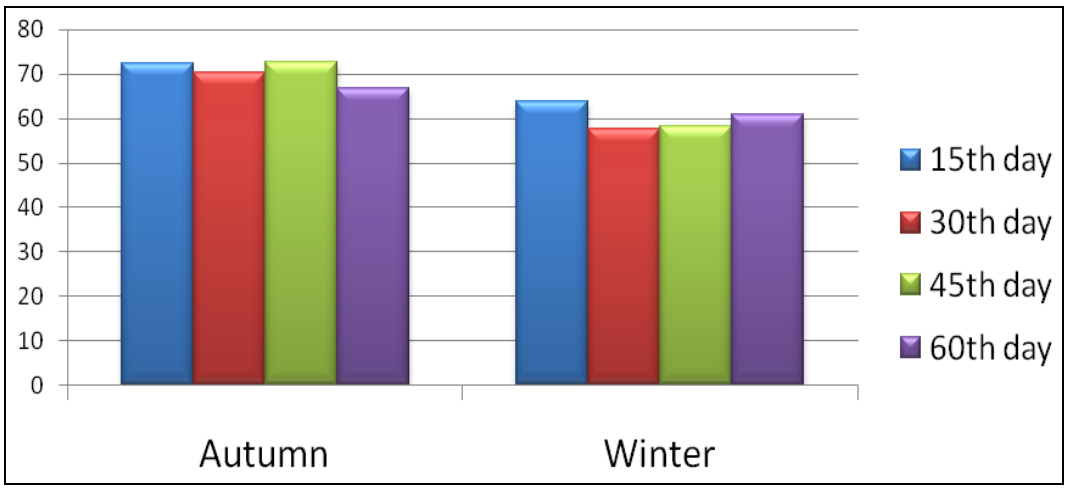

Fig 3: Bar diagram depicting Temperature humidity index of autumn and winter season at different periods (Mean±SE).

Significant differences were observed within season as well as between seasons. A significantly lower level of THI (p<0.01) was observed on day 60 during autumn whereas significantly lower level of THI (p<0.01) was observed on days 30 and 45 as compared to day 60 and 45. The THI was significantly higher during autumn as compared to winter is consistent with the findings of Rathwa *et al.* (2017) [31] who also reported a higher THI during summer. Silanikove *et al.* (2000) [34] reported that the THI is a good indicator of stressful thermal climatic conditions and extreme distress and animal are unable to preserve thermoregulatory mechanisms and normal body temperature. THI at values more than 78 and THI values 75-78 stressful and THI values of 70 or less are considered comfortable.

3.2 Biochemical parameters

Serum biochemical parameters provide a brief idea about body homeostasis, its response to disease and production. Comparision with standard values is essential to eliminate bias due to the possible influences of variants like breed, age, sex and environment, etc. The physiological responses of animals to environmental stress during winter and summer and their energy balance showed that seasonal heat and cold stress have profound effects on serum biochemical parameters (Ronchi *et al.* 1995 and Bengoumi *et al.* 1997) [32, 5].

3.2.1 Total serum protein (g/dl)

Total blood serum proteins serve an important function in the body for maintaining colloid osmotic pressure, blood pressure, acid-base balance, transport of nutrients, hormones, enzymes etc. During autumn, the mean total serum protein concentration was highest on 45th days (6.57±0.38) lowest on 15th days (6.27±0.23) while, it was 6.30±0.32 and 6.51±0.47 during 30th and 60th day respectively (Table 4, Fig 4). During the winter season, the mean value of serum protein concentration (gm/dl) was 6.32±0.38, 5.73±0.41, 6.35±0.43 and 5.55±0.37 at 15th, 30th, 45th and 60th days respectively (Table 4).

The mean value of serum protein was found to be decreased during winter as compared to autumn. However, the variation was non-significant within season and between seasons. The lower total protein level in winter may be due to additional energy requirement to combat cold stress. However, inadequate availability of quality feeds and fodders on account of cold might have possibly led to excessive breakdown of proteins as an alternative to meet up the energy requirements.

Obtained results were in conformation with the findings of Hilal Musadiq khan *et al.* (2016) [40] in Corridale sheep and goat and Ghosh *et al.* (2013) [12] in tropical goat. However, Urwat *et al.* (2015) [38] reported significant decrease in summer season than winter seasonin Changthangi Pashmina goats

Table 4: Total Serum protein concentration (gm/dl) of Black Bengal goats in autumn and winter season at different periods (Mean±SE).

Days	Autumn	Winter	t value (P critical)
15th day	6.27±0.23	6.32±0.38	0.90^{NS}
30th day	6.30±0.32	5.73±0.41	0.21^{NS}
45th day	6.57±0.38	6.35±0.43	0.72^{NS}
60th day	6.51±0.47	5.55±0.37	0.07^{NS}
F value	0.17^{NS}	1.08^{NS}	

NS - P≥0.05; *P<0.05 - Significant; **P<0.01- Highly Significant

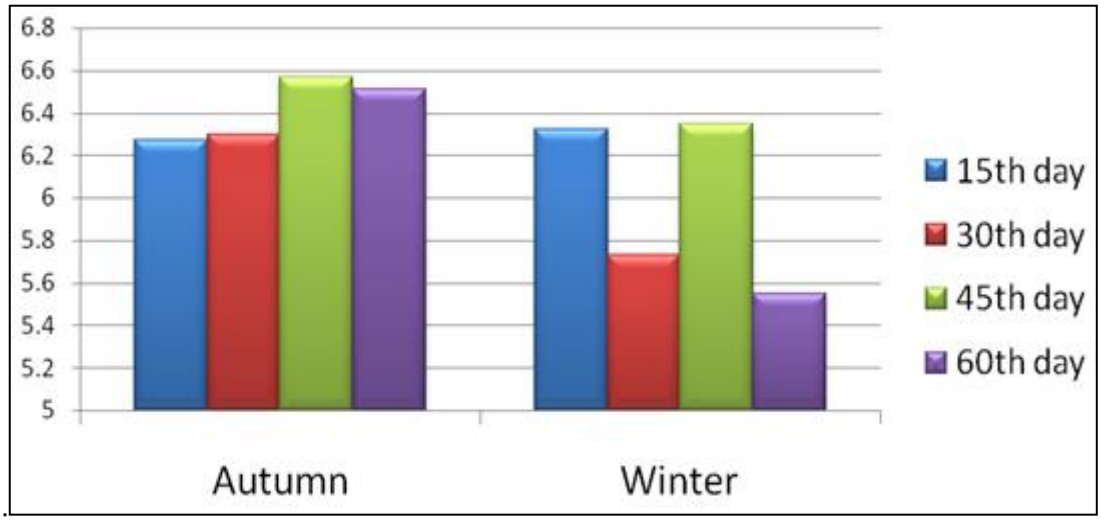

Fig 4: Bar diagram depicting Serum protein concentration (gm/dl) of Black Bengal goats in autumn and winter season at different periods (Mean±SE).

3.2.2 Serum Glucose Concentration (mg/dl)

Glucose is the principal source of energy in a mammalian cell. A relatively small change in glucose level in body can be tolerated without adverse effects on the health of the animal (Kaneko *et al.*, 1997) [17]. In the present study, the mean value of glucose (mg/dl) of Black Bengal Goat was50.40±2.39, 49.54±2.61, 51.02±3.32, 51.02±2.84 in autumn and 52.63±2.60, 51.54±2.95, 52.01±2.28, 51.13±2.94 in winter on day15th, 30th, 45th& 60threspectively (Table 5, Fig 5).

It reflects a non- significant variation period. It was minimum at 60th day, followed by 30th day. The t- value (p critical) shows non-significant effect of season on 30th, 45th and 60th day while the effect was significant on 15th day (p critical = 0.03). Although the overall mean values of glucose increased during winter as compared to autumn. So, non significant differences were observed in glucose level within season whereas it was significantly higher on day 15 during winter.

The results were in accordance with those of corriedale sheep and goat (khan *et al.* 2016) [40].

However, Nawel *et al.* (2014) [26] observed non-significant difference in glucose level in goats while Al-Haidary *et al.* (2012) [2] reported a significant increase during summer season than winter in Najdi sheep.

During the winter season animals consume more feed due to

increase in basal metabolic rate that fulfil the requirement of glucose in the body and also is associated with the inhibition of insulin secretion during low ambient temperature (Nazifi *et al.* 2003) [27].

Table 5: Serum glucose concentration (mg/dl) of Black Bengal goats in Autumn and Winter season at different periods (Mean±SE).

Days	Autumn	Winter	t value (P critical)
15th day	50.40±2.39[a]	52.63±2.60[a]	0.03*
30th day	49.54±2.61[a]	51.54±2.95[a]	0.06[NS]
45th day	51.02±3.32[a]	52.01±2.28[a]	0.50[NS]
60th day	51.02±2.84[a]	51.13±2.94[a]	0.92[NS]
F value	0.06[NS]	0.06[NS]	

NS - $P \geq 0.05$; *$P<0.05$ - Significant; **$P<0.01$- Highly Significant.

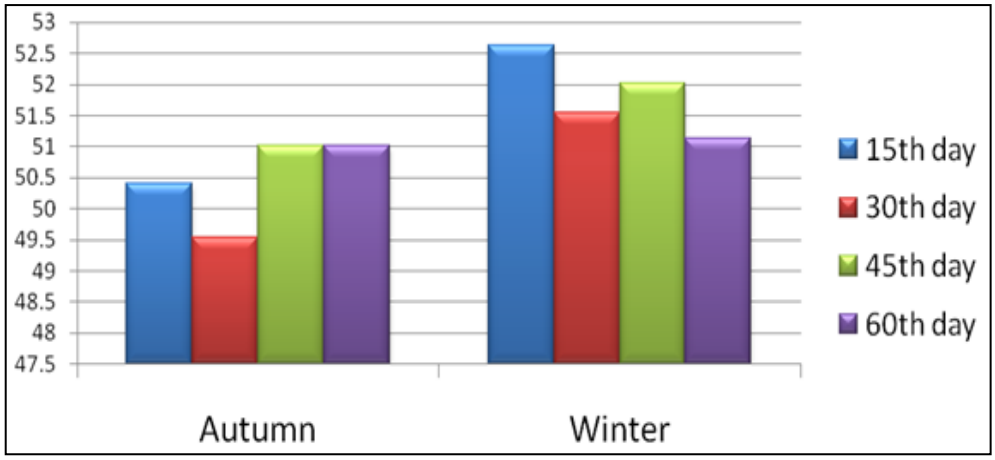

Fig 5: Bar diagram depicting Serum glucose concentration (mg/dl) of Black Bengal goats in autumn and winter season at different periods (Mean±SE).

3.2.3 Serum Inorganic phosphorus (mg/dl)

Phosphorus serves as major structural element and is associated with the normal function of all animal tissue by virtue of its role in the process of energy exchange. Besides, its role in growth and lactation, the ion plays a significant role in the process of reproduction (Little, 1970) [20].

Mean value of serum concentration of inorganic phosphorous (mg/dl) of Black Bengal goat was 7.62±0.44, 7.52±0.42, 7.43±0.39, 7.33±0.40 in autumn and 7.03±0.45, 6.94±0.45, 6.95±0.38, 6.80±0.37 in winter on day 15th, 30th, 45th and 60th respectively (Table 6, Fig 6).

The effect was non-significant on 15th, 30th& 45th days ($P \geq 0.05$) while it was significant on 60th day ($P<0.05$). The mean value was although lower in winter as compared to autumn in all the cases.

In the present study, a lower level of inorganic phosphorous observed during the winter season may be due to reduction in feed consumption and the higher level of inorganic phosphorous during autumn season may be due to a higher basal metabolic rate which leads to more feed consumption. Furthermore, less availability of green roughage during winter than autumn season may lead to low serum inorganic phosphorous level in goat. Similarly, low levels of serum phosphorus have implications based on earlier report (Minson, 1990) [25] in which phosphorus deficiencies were attributed to be more prevalent in tropical grazing regions and that this has tremendous implications on goat performance. However, Adewuyi and Adu (1983) observed a higher level of inorganic phosphorous during the summer season than winter season in sheep.

Table 6: Serum inorganic phosphorus concentration (mg/dl) of Black Bengal goats in Autumn and Winter season at different periods (Mean±SE).

Days	Autumn	Winter	t value (Pcritical)
15th day	7.62±0.44	7.03±0.45	0.13[NS]
30th day	7.52±0.42	6.94±0.45	0.13[NS]
45th day	7.43±0.39	6.95±0.38	0.11[NS]
60th day	7.33±0.40	6.80±0.37	0.03[*]
F value	0.08[NS]	0.05[NS]	

NS - $P \geq 0.05$; *$P<0.05$ - Significant; **$P<0.01$- Highly Significant.

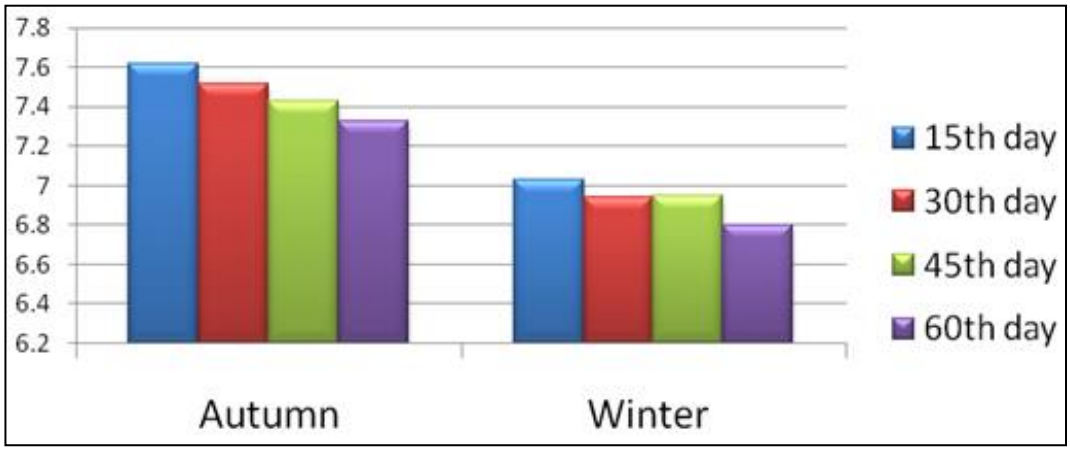

Fig 6: Bar diagram depicting Serum inorganic phosphorus concentration (mg/dl) of Black Bengal goats in autumn and winter season at different periods (Mean±SE).

3.2.4 Serum Calcium concentration (mg/dl)

Mean value of serum calcium concentration was found to be higher in Autumn as compared to Winter on 15th, 30th, 45th as well as 60th day although the difference was non- significant on 30th, 45th and 60th day (P≥0.05) and significant at 15th day (*P*<0.01) (Table 7, Fig 7). F-value as obtained from one was ANOVA during autumn was 0.74 and during winter was 0.44 the effect was non- significant in both the cases (*P*>0.05). Further the mean value of serum calcium concentration (mg/dl) was highest on 15th day (8.40±0.16). During winter the value was highest on 15th day (7.96±0.15) and lowest on 60th day (7.76±0.14).

Table 7: Serum calcium concentration (mg/dl) of Black Bengal goats in Autumn and Winter season at different periods (Mean±SE).

Days	Autumn	Winter	t value (Pcritical)
15th day	8.40±0.172	7.96±0.147	0.02*
30th day	8.26±0.150	7.97±0.149	0.09^{NS}
45th day	8.17±0.155	7.87±0.134	0.06^{NS}
60th day	8.08±0.158	7.76±0.142	0.07^{NS}
F value	0.74^{NS}	0.44^{NS}	

NS - P≥0.05; *P<0.05 - Significant; **P<0.01- Highly Significant.

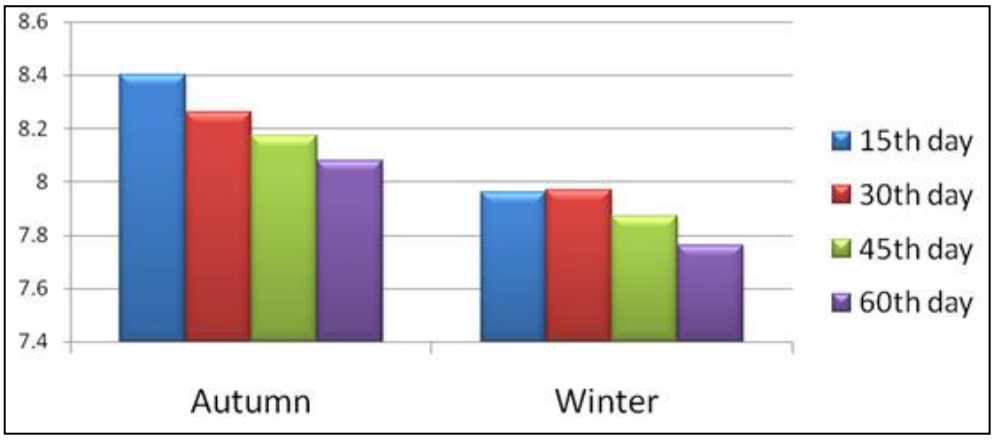

Fig 7: Bar diagram depicting Serum calcium concentration (mg/dl) of Black Bengal goats in autumn and winter season at different periods (Mean±SE).

3.2.5 Magnesium (mEq/liter)

Magnesium has a fundamental role as a co-factor in more than 300 enzymatic reactions involving energy metabolism and nucleic acid synthesis. It is also involved in several process including: hormone receptor binding; gating of calcium channels; trans activity and neuro-transmitter release (Fawcett *et al.*, 1999) [10]. In the present study, the mean value of serum concentration ofmagnesium (mEq/liter) of black bengal goat were 2.16±0.12, 2.14±0.11, 2.13±0.11, 2.10±0.10 and 2.04±0.11, 1.98±0.11, 1.95±0.11, 1.90±0.10 respectively (Table 8, Fig 8) during Autumnand Winter on day 15th, 30th, 45th& 60th. During autumn season the serum magnesium level was increased as compared to winter season. Our findings is in agreement with A.A Dar *et al.* (2014) [9]. Furthermore, the exchange of radio Mg in bone has been recorded 5 to 10 times greater in young than old animals (Breibart*et al.*, 1960) [6] owing to more water content in former than later (Fontenot *et al.* 1989) [11].

Table 8: Serum magnesium concentration (mEq/liter) of Black Bengal goats in Autumn and Winter season at different periods (Mean±SE).

Days	Autumn	Winter	t value (P critical)
15th day	2.16±0.120	2.04±0.110	0.14^{NS}
30th day	2.14±0.112	1.98±0.113	0.06^{NS}
45th day	2.13±0.106	1.95±0.109	0.06^{NS}
60th day	2.10±0.104	1.90±0.102	0.002**
F value	0.06^{NS}	0.27^{NS}	

NS - P≥0.05; *P<0.05 - Significant; **P<0.01- Highly Significant.

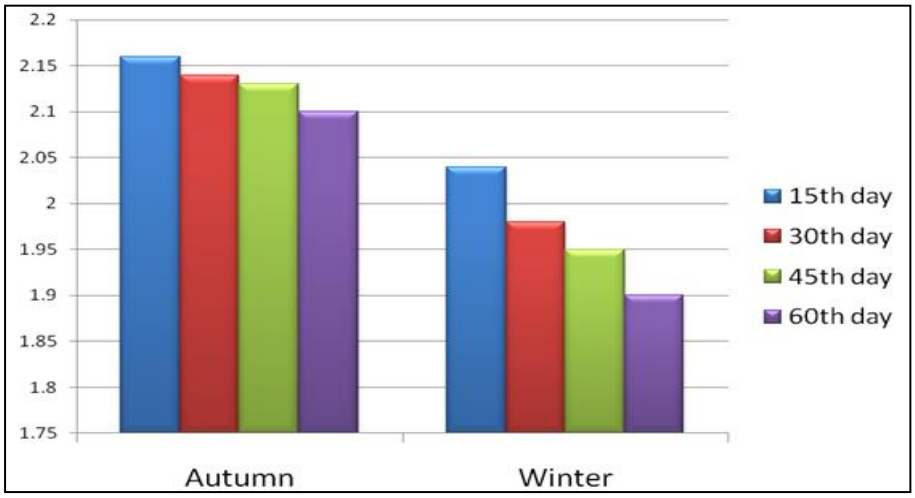

Fig 8: Bar diagram depicting Serum magnesium concentration (mEq/liter) of Black Bengal goats in autumn and winter season at different periods (Mean±SE).

4. References

1. Adewuyi AA, Adu IF. Seasonal variation in the levels of some blood components of indigenous and crossbred sheep. Tropical Animal Production 1984;3:223-230.
2. Al-Haidary AA, Aljumaah RS, Alshaikh MA, Abdoun KA, Samara EM, Okab AB *et al*. Thermoregulatory and Physiological responses of Najdi sheep exposed to environmental heat load prevailing in Saudi Arabia. Pakistan Veterinary Journal 2012;32(4):515-519.
3. Alila-Johansson A, Eriksson L, Soveri T, Laakso ML. Daily and annual variation of free fatty acid, glycerol and leptin plasma concentrations in goats (*Capra hircus*) under different photoperiods. Comparative Biochemistry and Physiology 2004;138:119-131.
4. Bagainski ES. Direct micro determination of serum calcium. Clinical Chemical Acta 1973;46:46.
5. Bengoumi M, Faye B, Elkasmi K, De La Farge F. Clinical enzymology in the dromedary camel (*Camelus dromedaries*). Part 2. Effect of season, age, sex, castration, lactation and pregnancy on serum AST, ALT, GGT, AP and LDH activities. Journal of Camel Practice and Research 1997;4:25-29.
6. Breibart S, Lee JS, Coord AMC, Forbes GB. Elation of Age to Radiomagnesium Exchange in Bone.Proc. Soc. Experimental Biology Medicine 1960;105(2):361-363.
7. Ceylan A, Serin I, Aksit H, Seyrek K. Concentration of some elements in dairy cows with reproductive disorders. The Bulletin of the Veterinary institute in Pulawy 2008;52:109-112.
8. Chaffee RRJ, Roberts JC. Temperature acclimation in birds and mammals. Annual Review of Physiology 1971;33:155-202.
9. Dar AA, Jadhav RK, Dimri U, Khan AAHM, Sharma, MC. Effect of physiological status and seasonal variation on plasma mineral profile of sheep in Kashmir vally. Scientific Research and Essays 2014;9(4):69-76.
10. Fawcett WJ, Haxby EJ, Male DA. Magnesium: Physiology and Pharmacology. British Journal of Anaesthesia 1999;83(2):302-320.
11. Fontenot JP, Allen VG, Bunce GE, Goff JP. Factors Influencing Magnesium Absorption and Metabolism in Ruminants. Journal of Animal Science 1989:67(12):3445-3455.
12. Ghosh S, Singh AK, Haldar C. Adaptive and ecological significance of the seasonal changes in haematological, biochemical and hormonal parameters in the tropical goat Capra hircus. Journal of Endocrinology and Reproduction 2013;17(2):113-122.
13. Gindler EM, Heth DA. Colorimetric determination with bound Calmagite of magnesium in human blood serum. Clinical Chemistry 1971;17:662.
14. Goodwin JF. Quantification of serum inorganic phosphorus, phosphatase, and urinary phosphate without preliminary treatment. Clinical Chemistry 1970;16(19):776.
15. Gornall AG. Determination of serum proteins by means of the biuret reaction. Journal of Biological Chemistry 1949;77:751.
16. Doumas BT. Standards for total serum protein assays: A collaborative study. (1975) Clinical Chemistry 1975;21:1159.
17. Kankeko JJ, Harvey JW, Bruss ML. Clinical biochemistry of domestic animals. 5th edition, Harcourt Brace & Company, Singapore 1997.
18. Khan JR, Ludri RS. Changes in blood glucose, plasma non-esterified fatty acids and insulin in pregnant and non-pregnant goats. Tropical Animal Health Production 2002;34:81-90.
19. Kumar P, Sharma MC, Joshi C. Effect of biochemical profile concurrent with micro-mineral deficiencies in buffaloes (*Bubalus bubalis*) of eastern Uttar Pradesh. Indian Journal of Animal Science 2007;77:86-91.
20. Little DA. Factors of importance in the phosphorus nutrition of beef cattle in Nothern Australia. Australian Veterinary Journal 1970;46:240-248.
21. MacHugh DE, Bradley DG. Livestock genetic origins: goats buck the trend. Proceedings of the National Academy of Sciences USA 2001;98:5382-5384.
22. Maloity GMO, Taylor CR. Water requirements of African goats and haired sheep. Journal of Agricultural Science Cambdrige 1971;77:203.
23. Meferlane WV, Howard B. Comparative water and energy economy of wild and domestic animals. Symposia of the Zoological Society of London 1972;31:261.
24. Merrill LB, Reardon DO, Leinweber CL. Cattle, Sheep, Goats mixlem up fer higher gains. Texas Agricultural Programme 1965;12:13.
25. Minson DJ. Forage in Ruminant Nutrition. Academic Press Inc 1990.
26. Nawel A, Abdennour C, Ouanes I. Variation of

Biological Markers under hot and cold seasons in goats. Advances in Environmental Biology 2014;8(21):289-295.
27. Nazifi S, Saeb M, Rowghani E, Kaveh K. The influence of thermal stress on serum biochemical parameters of Iranian fat-tailed sheep and their correlation with triiodothyronine and thyroxine and cortisol concentrations. Comparative Clinical Pathology 2003;12:135-139.
28. Nazifi S, Saeb M, Rowghani E, Kaveh K. The influence of thermal stress on serum biochemical parameters of Iranian fat-tailed sheep and their correlation with triiodothyronine and thyroxine and cortisol concentrations. Comparative Clinical Pathology 2003;12:135-139.
29. Piccione G, Caola G, Claudia C, Grasso F, Runzo SC, Zumbo A *et al*. Selected biochemical serum parameters in ewes during pregnancy, post-parturition, lactation and dry period. Animal Science paper and reports 2009;27(4):321-330.
30. Piccione G, Messina V, Vazzana I, Dara S, Giannetto C, Assenza A. Seasonal variations of some serum electrolyte concentrations in sheep and goats. Comparative Clinical Pathology 2012;21:911-915.
31. Rathwa SD, Vasava AA, Pathan MM, Madhira SP, Patel YG, Pande AM. Effect of season on physiological, biochemical, hormonal, and oxidative stress parameters of indigenous sheep. Science central Journal 2017;10(6):650-654.
32. Ronchi B, Bernabucci U, Lacetera NG, Nardone A, Bretoni G. Effects of heat stress on metabolic status of Frisisan heifer calves. Zootec Nutrition Anim 1995;21:209-221.
33. Shelton M, Spiller D. Observations on the breeding season of Spanish does. Texas Agricultural Experimental Station Bulletin 1977, 3445.
34. Silanikove N. The physiological basis of adaptation in goats to harsh environments. Small Ruminant Research 2000;35:181-193.
35. Suttle NF. Mineral Nutrition of livestock, 4th Edition, Cabi Publishing, USA 2010.
36. Swanson KS, Kuzmuk KN, Schook LB, Fahey GC. Diet affects nutrient digestibility, haematology and serum chemistry of senior and weanling dogs. Journal of Animal Science 2004;82:1713-1724.
37. Trinder P. Determination of Glucose in Blood Using Glucose Oxidase with an Alternative Oxygen Acceptor. Annals of clinical Biochemistry 1969;6:24.
38. Urwat U, Fazili IS, Ruby Rafeequi TA, Shiekh FD, Naykoo NA, Malik FA *et al*. Sex and Seasonal variations in the serum biochemical profile of Changthangi Pashmina goats. Animal Science Reproduction 2015;9(4):133-148.
39. Yokus B, Cakir DU, Kanay Z, Toprak G, Uysal E. Effects of seasonal and physiological variations on the serum chemistry, vitamins and thyroid hormone concentrations in sheep. Journal of Veterinary Medicine Acta 2006;53:271-276.
40. Zulfqar H, Jain RK, Khan N. Recent advances in role of chromium and its antioxidant combinations in poultry nutrition: A review. Veterinary World 2016;9(12):1392-1396.