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Effect of dietary energy levels on performance and blood biochemical parameters of deccani ewes during summer

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Abstract

The present study was conducted to evaluate the effect of varying dietary energy levels on the performance of Deccani ewes during summer. Twenty-four non-pregnant Deccani ewes (23.78 ± 0.44 kg) were randomly allotted to three dietary treatments comprising maintenance energy (NE), 10% higher energy (HE-10) and 20% higher energy (HE-20) than the maintenance requirement recommended by ICAR (2013). Experimental diets were fed for 60 days at 3.1% of body weight. Thereafter, all animals received the maintenance diet according to the stage of gestation. Feed intake, dry matter intake (DMI) and body weight were recorded at fortnightly intervals. Dietary energy levels had no significant effect ($P>0.05$) on feed intake, DMI or body weight throughout the experimental period. The ewes maintained normal feed consumption and body weight gain despite exposure to severe summer heat stress conditions. The results indicated that feeding Deccani ewes at the maintenance energy level of 127 kcal ME/kg $W^{0.75}$ as recommended by ICAR (2013) was adequate to maintain performance during summer and increasing dietary energy by 10 or 20% above maintenance offered no additional benefit. Dietary energy levels had no significant effect on serum biochemical parameters except glucose, protein, and globulin at 15 d before lambing (BL). These parameters were lower ($P<0.05$) in high-energy groups than in the normal-energy group, while HE-10 and HE-20 groups were comparable. Glucose and globulin declined ($P<0.01$), triglycerides increased ($P<0.05$), and cholesterol decreased ($P<0.01$) with advancing gestation, indicating greater influence of physiological stage than dietary energy on metabolic profile. Thus, present study indicated that feeding ewes with 127 Kcal ME/kg $W^{0.75}$ as per ICAR (2013) requirements for maintenance was optimum for performance (intake and bodyweight) and adaptability to summer stress in Deccani ewes.

Keywords: Deccani sheep, dietary energy, heat stress, feed intake, body weight, serum biochemical parameters

Introduction

Sheep play an important role in the livelihood of rural communities in India by providing meat, wool, skin and manure. Among the indigenous breeds, Deccani sheep are well adapted to the semi-arid regions of southern India and contribute significantly to mutton production. However, high ambient temperatures during summer may adversely affect feed intake, nutrient utilization and animal performance.

Energy is the most critical nutrient influencing maintenance and productive functions in sheep. Under heat stress conditions, changes in energy metabolism may alter nutrient requirements and affect animal performance. Information on the optimum dietary energy requirement of Deccani sheep during summer is limited. Therefore, the present study was undertaken to evaluate the effect of varying dietary energy levels on feed intake and body weight changes of Deccani ewes during summer conditions.

Materials and methods

Experimental animals and management

The experiment was conducted using 24 healthy non-pregnant Deccani ewes aged between 2 and 4 years with an average body weight of 23.78 ± 0.44 kg. The animals were procured from Livestock Research Station, Mahbubnagar, and Livestock Farm Complex, Hyderabad.

Ewes were randomly allocated into three treatment groups of eight animals each under a completely randomized design.

Animals were housed in a well-ventilated shed with facilities for individual feeding and watering. Prior to the commencement of the experiment, all animals were dewormed and vaccinated against sheep pox, peste des petits ruminants and enterotoxaemia as per standard schedules. Three sorghum stover-based complete diets were formulated: 1. NE: Maintenance energy level (ICAR, 2013) [1], 2. HE-10: 10% higher energy than maintenance, 3. HE-20: 20% higher energy than maintenance (Table 1). All diets were iso-nitrogenous and met nutrient requirements except for energy concentration. During the first 60 days, animals received their respective experimental diets at 3.1% of body weight. From day 61 to the 108th day of gestation, all ewes were fed the maintenance diet at 3.1% of body weight. During the final six weeks of gestation until lambing, the maintenance diet was offered at 3.73% of body weight to meet increased nutrient requirements.

Table 1: Ingredient composition (%) of experimental diets fed to Deccani ewes

Ingredient	NE	HE-10	HE-20
Sorghum stover	60	55	50
Maize	-	15	38.3
De-oiled rice bran	15.6	2	-
Groundnut cake	9	9	7.5
Cottonseed cake	1	4	-
Red gram chunni	3	5.8	-
Molasses	10	8	2.8
Urea	0.7	0.5	0.7
Salt	0.5	0.5	0.5
Mineral and vitamin mixture*	0.2	0.2	0.2

*The mineral and vitamin mixture per kg of diet provided: vitamin A, 15000 IU; vitamin D3, 3000 IU; vitamin E, 19.5 IU; vitamin B1, 26 mg; vitamin B6, 2.72 mg; vitamin B12, 60 mg; Ca, 4.4 g; P, 2 g; Mg, 0.8 g; Cu, 0.04 g; Co, 2 mg; I, 4 mg; Fe, 0.12 g; Mn, 0.024 g; Se, 0.6 mg; Zn, 0.044 g.

Proximate Analysis

The proximate analysis of feeds (Organic Matter, Crude Protein, Ether Extract, Crude Fibre, Nitrogen Free Extract and Total Ash Content (%)) was performed as per the procedures described in AOAC (2012) [2].

Feeding and data collection

Feed was offered twice daily at 10:00 AM and 2:30 PM in equal proportions. Fresh drinking water was provided ad libitum. Feed offered and refusals were recorded daily for estimation of feed intake and dry matter intake. Body weights were recorded at fortnightly intervals before feeding and watering.

Blood biochemical parameters

Blood was collected from individual ewes on 45th and 120th day of experiment and 15th day before expected day of lambing. Blood samples were collected aseptically from jugular vein of ewes into clean sterilized glass tubes and kept in slanted position at room temperature for separation of serum. The collected serum samples were centrifuged at 3000 rpm for 5 minutes and transferred to 5 ml Eppendorf tubes and stored at -20°C for estimation of various biochemical constituents. Serum biochemical parameters were estimated by using a commercial kit (Coral Clinical

Systems, Goa) and following methods: 1) Serum glucose by enzymatic method (Trinder, 1969a) [3, 4], 2) Serum total protein by Biuret method (Reinhold, 1953) [5], 3) Serum albumin by Bromocresol green (BCG) method (Dumas *et al.*, 1971) [6], 4) Serum globulin was calculated by using formula Globulin (g/dl) = Total proteins (g/dl) - Albumin (g/dl), 5) Albumin-Globulin ratio was calculated by following formula: Albumin -globulin ratio (A/G) ratio = Albumin (g/dl) / Globulin (g/dl), 6) Serum cholesterol was estimated using commercial kit. Values obtained were calculated by (Absorbance of Test/Absorbance of Standard) x Conc. of Standard (mg/dl) (Allain *et al.*, 1974) [7], 7) Serum triglycerides by Glycerol phosphate oxidase (GPO) method (Trinder, 1969b) [3, 4] and 8) Blood urea nitrogen was estimated by enzymatic method (Bretaudiere *et al.*, 1976) [8] using kit supplied by Accurex Biomedical Private Limited, Boisar, Maharashtra

Statistical analysis

Data were analyzed using SPSS Version 15.0. One-way and two-way analysis of variance under the generalized linear model procedure was employed. Treatment means were compared using Duncan's Multiple Range Test (Duncan, 1955) [9] and significance was declared at $P < 0.05$. All the statistical procedures were done as per Snedecor and Cochran (1994) [10].

Results and discussion

1. Chemical composition of diets

The chemical composition of the sorghum stover-based complete diets is as shown in Table 2. The organic matter, crude protein, ether extract, crude fibre, nitrogen free extract and total ash content (%) of NE diet on dry matter basis was 89.96, 9.72, 1.64, 30.17, 48.43 and 10.04 respectively. The corresponding values for HE-10 diet was 91.30, 9.69, 2.15, 27.50, 51.96 and 8.70 and for HE-20 was 92.58, 9.68, 2.00, 23.51, 57.39 and 7.42 respectively.

Table 2: Proximate composition of experimental diets (% on dry matter basis)

Constituent	NE	HE-10	HE-20
Dry matter	90.50	90.60	90.46
Organic matter	89.96	91.30	92.58
Crude protein	9.72	9.69	9.68
Ether extract	1.64	2.15	2.00
Crude fibre	30.17	27.50	23.51
Nitrogen free extract	48.43	51.96	57.39
Total ash	10.04	8.70	7.42

NE- Normal energy diet: maintenance energy requirement as per ICAR (2013) [1].

HE10- 10% higher energy than the maintenance requirement.

HE20-20% higher energy than the maintenance requirement.

2. Feed intake and dry matter intake

Dietary energy levels did not significantly influence feed intake or dry matter intake during the first 60 days of the experiment (Table 3 and 4). Average feed intake during the first fortnight was 819.8, 818.9 and 818.9 g/day for NE, HE-10 and HE-20 groups, respectively. Corresponding dry matter intakes were 737.8, 737.0 and 737.0 g/day. Similar trends were observed throughout the first four fortnights. Following the treatment period, all animals received the maintenance diet and feed as well as dry matter intakes remained comparable among groups until lambing. The absence of differences in feed intake among dietary

treatments suggests that increasing dietary energy concentration by 10 or 20% above maintenance did not alter voluntary feed consumption in Deccani ewes. During the study period, Temperature Humidity Index (THI) values ranged from 89.76 to 94.38, indicating severe heat stress conditions. Heat stress is generally associated with reduced feed intake as animals attempt to minimize metabolic heat production. However, Deccani sheep maintained normal intake, likely due to their adaptation to hot climates,

provision of adequate shade and unrestricted access to drinking water.

These findings agree with reports of *Giger-Reverdin et al. (2013)* [11] and *Fiaz et al. (2012)* [12], who observed no significant effect of dietary energy level on feed intake under heat stress conditions. Similar observations have also been reported by *Rekik et al. (2008)* [13] and *Hossain et al. (2003)* [14].

Table 3: Effect of dietary energy levels on fortnightly daily feed intake (g/day) in Deccani ewes

Diet	1	2	3	4	5	6	7	8	9	10
NE	819.8	836.1	855.9	855.9	868.0	855.1	875.7	901.1	934.8	975.2
HE-10	818.9	802.5	825.8	837.0	858.5	856.8	885.2	915.8	938.0	1055.7
HE-20	818.9	791.4	827.5	848.2	876.6	870.6	890.4	920.9	946.8	994.8
SEM	15.024	16.282	15.843	15.628	15.803	15.987	17.244	18.569	18.732	25.052
N	24	24	24	24	24	24	24	24	24	24
P value	1.001	0.526	0.702	0.893	0.905	0.917	0.945	0.911	0.967	0.410

NE: Normal energy diet (ICAR-2013) [1]; HE 10: High energy diet 1; HE 20: High energy diet 2 during first 60 days of feeding period.

SEM: Standard Error Mean; P value: Probability value; N: Number of observations.

Table 4: Effect of dietary energy levels on fortnightly daily dry matter intake (g/day) in Deccani ewes

Diet	1	2	3	4	5	6	7	8	9	10
NE	737.8	752.5	770.3	770.3	781.2	769.6	788.2	811.0	841.3	877.7
HE-10	737.0	722.3	743.2	753.3	772.7	771.1	796.7	824.2	844.2	950.1
HE-20	737.0	712.2	744.8	763.4	789.0	783.5	801.3	828.9	852.1	895.3
SEM	13.522	14.654	14.259	14.241	14.223	14.388	15.520	16.712	16.859	22.547
N	24	24	24	24	24	24	24	24	24	24
P value	1.001	0.526	0.702	0.893	0.905	0.917	0.945	0.911	0.967	0.410

NE: Normal energy diet (ICAR-2013) [1]; HE 10: High energy diet 1; HE 20: High energy diet 2 during first 60 days of feeding period.

SEM: Standard Error Mean; P value: Probability value; N: Number of observations.

3. Body Weight Changes

No significant differences were observed in the body weights among treatment groups throughout the experimental period (Table 5). The maintenance energy level recommended by ICAR (2013) [1], equivalent to approximately 127 kcal ME/kg W^{0.75}, was sufficient to sustain body weight and support normal physiological functions under severe summer conditions. Increasing dietary energy by 10 or 20% above maintenance did not improve body weight gain. The gradual increase in body

weight observed during the later stages of the experiment was mainly attributable to pregnancy and fetal growth rather than treatment effects. Similar findings have been reported by *Macías-Cruz et al. (2016)* [15], *Hossain et al. (2003)* [14] and *Koyuncu and Canbolat (2009)* [16], who observed no significant changes in body weight with moderate increases in dietary energy. In contrast, studies involving substantially higher energy supplementation and *ad libitum* feeding have reported improved body weight gains (*Kaminski et al., 2015; Khalifa et al., 2015 and Naqvi et al., 2013*) [17, 18, 19].

Table 5: Effect of dietary energy levels on fortnightly average body weights (kg) of Deccani ewes

Diet	Start	1	2	3	4	5	6	7	8	9	10
NE	23.80	24.27	24.85	24.85	25.20	24.82	25.42	26.16	26.30	27.16	28.17
HE-10	23.27	23.30	23.97	24.30	24.92	24.87	25.70	26.58	26.88	27.42	29.01
HE-20	23.77	22.97	24.02	24.62	25.45	25.27	25.85	26.73	27.48	27.98	28.87
SEM	0.436	0.408	0.459	0.573	0.458	0.464	0.500	0.539	0.543	0.500	0.594
N	24	24	24	24	24	24	24	24	24	24	24
P-value	1.001	0.526	0.702	0.893	0.905	0.917	0.945	0.911	0.864	0.851	0.839

NE: Normal energy diet (ICAR-2013) [1]; HE 10: High energy diet 1; HE 20: High energy diet 2 during first 60 days of feeding period.

SEM: Standard Error Mean; P value: Probability value; N: Number of observations.

4. Serum biochemical parameters

4.1 Serum glucose, serum triglycerides and serum cholesterol

Variation in dietary energy levels had no effect on serum glucose on 45th and 120th day, while on 15th day before expected day of lambing, the concentration of glucose in serum was lower ($P < 0.01$) in HE-10 and HE-20 group ewes when compared to NE group ewes. No significant effect was observed on serum triglycerides and serum cholesterol by the supplementation of different dietary energy levels (Table and 6.1).

However, the time of blood collection irrespective of diets influenced blood glucose, triglycerides and serum cholesterol values. Significantly ($P < 0.01$) highest serum glucose value was observed on 45th day (85.09 mg/dl), followed by 15th day before expected day of lambing (70.54 mg/dl) and lowest levels were observed on 120th day (64.93 mg/dl) of blood collection. Serum triglyceride values were significantly ($P < 0.01$) higher on 120th day and 15 days before lambing and lower on 45th day. Whereas, serum cholesterol values were significantly ($P < 0.01$) higher on 45th

day, followed by 120th day and lower on 15 days before lambing.

The elevated glucose concentration on day 45 may be attributed to heat stress-induced glycogenolysis mediated by glucocorticoids (Thompson, 1973) [20], whereas the decline during late gestation likely reflects increased maternal glucose utilization and fetal glucose demand (Duehlmeier *et al.*, 2013) [21]. The absence of a consistent dietary effect on glucose agrees with previous studies reporting minimal changes following energy supplementation (Karikari and Blas, 2009; Kawardeep *et al.*, 2013; Hashem and El-Zarkouny, 2013) [22, 23, 24], although other authors have reported increased glucose concentrations with high-energy diets (Mosaad and Derar, 2009; Zabuli *et al.*, 2010; Senosy *et al.*, 2013) [25, 26, 27].

Serum cholesterol and triglyceride concentrations were not affected by dietary energy level, indicating that moderate

increases in dietary energy did not alter lipid metabolism. However, irrespective of treatment, serum cholesterol declined progressively from day 45 to late gestation, while triglyceride concentrations increased on day 120 and 15 days before lambing. The reduction in cholesterol may reflect its utilization for steroid hormone synthesis and fetal development, while increased triglycerides are consistent with metabolic adaptations during pregnancy (Deghrouche *et al.*, 2013; Piccione *et al.*, 2009) [28, 29]. Similar findings have been reported by Kaminski *et al.* (2015) [17], whereas increased lipid concentrations with higher energy diets have also been documented under different nutritional regimens like high energy diets (Senosy *et al.*, 2013; Habibzad *et al.*, 2015) [27, 30], high protein diets (Mahmoud *et al.*, 2014) [31] or supplemented with fat (Hashem and El-Zarkouny, 2013) [24] or by flushing (Kia and Safdar, 2015 and Kia *et al.*, 2016) [32, 33].

Table 6: Effect of dietary energy levels on serum glucose, triglycerides and cholesterol in Deccani ewes

Diets	Glucose (mg/dL)			Triglycerides (mg/dl)			Cholesterol (mg/dl)		
	45d	120d	15d BL	45d	120d	15d BL	45d	120d	15d BL
NE	85.73	64.08	73.92 ^a	181.48	187.98	184.75	178.57	158.05	153.10
HE-10	84.73	64.76	70.03 ^b	177.29	191.57	188.87	177.74	159.20	153.92
HE-20	84.81	65.95	67.66 ^b	177.48	181.21	186.54	177.20	157.92	155.27
SEM	0.444	0.692	0.890	0.976	3.197	0.872	0.823	1.395	1.553
N	24	24	24	24	24	24	24	24	24
P value	0.611	0.557	0.008	0.140	0.424	0.155	0.805	0.925	0.859

^{ab}Means with different superscripts in a column differ significantly: $P < 0.05$.

NE: Normal energy diet (ICAR-2013) [1]; HE 10: High energy diet 1; HE 20: High energy diet 2 during first 60 days of feeding period. 45d and 120d: Blood collected on 45th and 120th day of experiment; 15d BL: 15th day from expected day of lambing.

SEM: Standard Error Mean; P value: Probability value; N: Number of observations.

Table 6.1: Serum glucose, triglycerides and cholesterol in Deccani ewes during different periods

Constituent	45d	120d	15d BL	SEM	P value
Glucose (mg/dl)	85.09 ^a	64.93 ^c	70.54 ^b	1.084	0.001
Triglycerides (mg/dl)	178.75 ^b	186.92 ^a	186.72 ^a	1.221	0.006
Cholesterol (mg/dl)	177.83 ^a	158.39 ^b	154.10 ^c	1.431	0.001

^{abc}Means with different superscripts in a column differ significantly: $P < 0.01$.

45d and 120d: Blood collected on 45th and 120th day of experiment; 15d BL: 15th day from expected day of lambing.

SEM: Standard Error Mean; P value: Probability value.

4.2 Serum protein, albumin, globulin, albumin-globulin ratio and blood urea nitrogen

Variation in dietary energy levels had significant ($P < 0.01$) effect on serum total protein where higher dietary energy levels (HE-10 and HE-20) showed lower serum protein values when compared to control during 15 days before lambing (Table 7 and 7.1). Whereas no effect was observed during 45th day and 120th day. Supplementation of NE, HE-10 and HE-20 diets showed no significant effect on the serum albumin concentration at 45th, 120th day and 15 days before lambing. The serum globulin content did not differ in ewes of NE, HE-10 and HE-20 groups on 45th and 120th day of feeding trial, while at 15 days before expected day of lambing, the globulin content was significantly ($P < 0.05$) higher in ewes of NE group than ewes of HE-10 and HE-20 groups. The serum albumin- globulin ratio values did not differ significantly on 45th day of feeding trail. However, on 120th day of trial, the serum albumin- globulin ratio was significantly ($P < 0.05$) lower in ewes of HE-10 group and higher in ewes of HE-20 group, while the ratio was intermediate in ewes of NE group. The serum albumin-globulin ratio in ewes at 15 days before expected day of lambing was significantly lower ($P < 0.05$) in NE and HE-10

groups and higher in ewes of HE-20 group. Variation in dietary energy had no effect on serum blood urea nitrogen concentration on 45 and 120th day of trial and at 15 days before expected day of lambing.

Irrespective of the diets supplemented to the ewes, all the serum biochemical parameters showed significant ($P < 0.05$) effect during 45th day, 120th day and 15 days before lambing of trial (Table 6). The serum total protein and serum globulin levels were significantly ($P < 0.01$) lower on 120th day of feeding trial and 15th day before lambing and higher on 45th day of feeding. The albumin and blood urea nitrogen levels significantly ($P < 0.01$) lower on 45th day and 15th day before expected day of lambing and were higher on 120th day of collection. The albumin- globulin ratio was significantly ($P < 0.01$) higher during 3rd collection (15 days before expected day of lambing) and lower on day 120 of feeding trial with intermediate values observed on 45th day of trial.

Dietary energy had no effect on serum total protein, albumin, globulin, or albumin:globulin (A:G) ratio during early and mid-pregnancy. However, total protein and globulin concentrations were lower in the high-energy groups during late gestation, while albumin and the A:G

ratio remained unaffected, suggesting maintenance of protein homeostasis despite changes in globulin levels. This reduction may be associated with increased fetal protein demand and greater nutrient partitioning towards conceptus growth during advanced pregnancy (Lloyd *et al.*, 2012; Duehlmeier *et al.*, 2013) [34, 21]. Irrespective of dietary treatment, serum protein and globulin concentrations declined as gestation advanced, whereas albumin and the A:G ratio remained relatively stable, indicating that physiological stage exerted a greater influence than dietary energy level. Similar findings of unchanged albumin and total protein following energy supplementation have been reported in ewes by Mosaad and Derar (2009) [25], Naqvi *et al.* (2011) [35] and Kia and Safdar (2015) [32] and in goats by Kwardeep *et al.* (2013) [23]. Likewise, Piccione *et al.* (2009) [29] and Antunović *et al.* (2002) [36] reported that serum albumin remains relatively stable during gestation, whereas globulin concentrations may decline because of increased fetal nutrient demand and physiological adaptations. In contrast, Senosy *et al.* (2013) [27] and Khalifa *et al.* (2015) [18] observed increased serum protein and globulin concentrations in ewes receiving high-energy diets,

suggesting that the response may depend on the level and duration of nutritional supplementation.

Blood urea nitrogen was unaffected by dietary energy level but varied with stage of gestation, with the highest concentrations observed on day 120. The absence of dietary effects indicates that moderate energy supplementation did not markedly alter protein metabolism, while temporal changes likely reflect physiological adaptations during pregnancy. Similar observations of unchanged blood urea concentration with dietary energy supplementation have been reported by Habibizad *et al.* (2015) [30], Senosy *et al.* (2013) [27], and Hashem and El-Zarkouny (2013) [24]. Likewise, Nazifi *et al.* (2003) [37] and Ghosh *et al.* (2013) [38] reported minimal effects of environmental stress on blood urea concentration in sheep and goats, respectively. Conversely, Antunovic *et al.* (2002) [36], Indu *et al.* (2014) [39], and Rathwa *et al.* (2017) [40] observed increased blood urea concentrations during heat stress. Overall, the present findings suggest that physiological stage rather than moderate dietary energy supplementation had a greater influence on protein metabolism during gestation.

Table 7: Effect of dietary energy levels on serum total protein, albumin and globulin, albumin- globulin ratio and blood urea nitrogen in Deccani ewes

Constituent	Day	NE	HE-10	HE-20	SEM	N	P value
Protein	45d	8.61	8.86	8.80	0.156	24	0.806
	120d	7.28	7.54	7.42	0.083	24	0.480
	15d BL	7.85 ^a	7.54 ^b	7.50 ^b	0.064	24	0.040
Albumin	45d	3.62	3.70	3.85	0.051	24	0.196
	120d	4.19	4.01	4.46	0.079	24	0.062
	15d BL	3.73	3.72	3.83	0.031	24	0.264
Globulin	45d	4.98	5.16	4.94	0.169	24	0.869
	120d	3.09	3.52	2.95	0.102	24	0.055
	15d BL	4.11 ^a	3.81 ^b	3.66 ^b	0.715	24	0.023
Albumin-globulin ratio	45d	0.79	0.71	0.80	0.043	24	0.703
	120d	1.37 ^a	1.14 ^b	1.60 ^a	0.071	24	0.025
	15d BL	0.90 ^b	0.98 ^b	1.06 ^a	0.024	24	0.030
Blood urea nitrogen	45d	17.78	17.10	16.48	0.235	24	0.075
	120d	18.00	18.19	18.43	0.178	24	0.925
	15d BL	18.13	18.70	17.35	0.346	24	0.251

^{ab}Means with different superscripts in a column differ significantly: $P < 0.05$.

NE: Normal energy diet (ICAR-2013) [1]; HE 10: High energy diet 1; HE 20: High energy diet

2 during first 60 days of feeding period. 45d and 120d: Blood collected on 45th and 120th day of experiment; 15d BL: 15th day from expected day of lambing.

SEM: Standard Error Mean; P value: Probability value; N: Number of observations.

Table 7.1: Serum protein, albumin, globulin albumin- globulin ratio and blood urea nitrogen in Deccani ewes during different periods

Constituent	45d	120d	15d BL	SEM	P value
Protein (g/dl)	8.75 ^a	7.41 ^b	7.63 ^b	0.093	0.001
Albumin (g/dl)	3.72 ^b	4.22 ^a	3.76 ^b	0.042	0.001
Globulin (g/dl)	5.03 ^a	3.19 ^c	3.86 ^b	0.113	0.001
Albumin-globulin ratio	1.12 ^b	0.77 ^c	1.63 ^a	0.054	0.001
Blood urea nitrogen (mg/dl)	17.12 ^b	18.20 ^a	17.39 ^b	0.159	0.011

^{abc}Means with different superscripts in a column differ significantly: $P < 0.05$.

45d and 120d: Blood collected on 45th and 120th day of experiment; 15d BL: 15th day from expected day of lambing.

SEM: Standard Error Mean; P value: Probability value

Conclusion

The present study demonstrated that Deccani sheep maintained normal performance despite exposure to severe heat stress conditions. Feeding ewes according to the maintenance energy requirement recommended by ICAR (2013) [1], equivalent to approximately 127 kcal ME/kg $W^{0.75}$, was adequate for performance and adaptation

during summer. Therefore, additional energy supplementation above maintenance is not economically justified under similar management conditions.

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41. SEM: Standard Error Mean; P value: Probability value; N: Number of observations.