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Effects of Level of Feeding and Season on Rectal Temperature and Blood Metabolites in Desert Rams (*Ovisaries*)

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Abstract: The effects of feeding three levels of chopped lucerne hay (high, medium and low) and season (winter vs summer) on the diurnal change of rectal temperature (DTr) and blood metabolites were investigated. Nine adult Desert rams aged 2-3 years and weighing 39.0-46.5 kg were randomly assigned to 3 groups (n=3) which represented each level of feeding. Throughout the experiment rectal temperature (Tr) measurements were performed twice daily in the morning and afternoon and blood samples were collected once weekly and analyzed. All animals showed a significantly higher afternoon Tr values during summer compared to winter. Food restriction significantly lowered serum total protein (STP) and albumin (SAB) levels during winter and in both seasons respectively compared to the control. However, all experimental groups had a significantly lower SAB level during summer compared to winter. During summer the group fed low level of lucerne hay had a significantly higher serum urea (SU) level compared to summer values. In conclusion, feed restriction and seasonal changes influenced the DTr and blood metabolites of rams.

Key words: Feed Restriction · Diurnal Pattern Rectal Temperature · Season Blood Metabolites

INTRODUCTION

The general nutritional requirements of sheep are limited by the voluntary food intake. The food intake, which influences the energy budget and thermoregulation, increases during winter as the maintenance requirements increase while in hot environment it decreases to avoid excess thermal loads [1].

In arid and semi-arid areas, feed shortage occurs in summer associated with thermal stress. Seasonal fluctuation of rain influence food availability, quality and consumption [2]. Energy for maintenance of vital physiological processes is derived from the organic matter in food, while heat increment of metabolism is associated with the level of feeding and the quality of food [3]. In hot environment, high planes of feeding decrease the heat tolerance of sheep[4] and increase the rectal temperature and respiration rate [5, 6]. However, low levels of feeding which decrease the metabolic heat production [7], reduce rectal temperature and respiration rate [6, 8]. In different seasons, the diurnal pattern in rectal temperature and respiration rate coincides with the diurnal changes in environmental temperature [9]. The changes in the nutritional status of sheep and seasonal changes in the thermal environment may influence the composition of blood [10]. The neuro-humoral system has a seasonal pattern in controlling the blood metabolites [11, 12]. The hot environment is associated with an increase in cortisol level and decrease in thyroid secretions, which in turn reduce protein and Carbohydrate metabolism. While exposure to cold weather, increases their secretions and functions [13]. In sheep the concentration of blood metabolites represents an integrated index of the nutritional supply in relation to utilization of nutrients and it reflects the nutritional status of the animal [14]. The level of sugar and nitrogen increases shortly after feeding and fall gradually to the fasting level [15]. The crude protein content of diet may influence the nutritional status and the level of blood metabolites in sheep. High and medium levels of crude protein increase digestibility and efficiency of microbial degradation [16, 17] leading to elevated total plasma protein, albumin and urea and consequently, elevated rate of urea excretion [18]. However, the intake of low level of crude protein maintained the urea concentration at a constant level

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with subsequent sharp decrease [19]. The concentrations of serum total protein and albumin, which are used as indices for nutritional status, increased during wet summer and decreased during winter in Desert sheep [20]. The aim of this work was to investigate the responses of Desert sheep to induced feed restriction in different seasons in terms of rectal temperature and blood metabolites.

MATERIALS AND METHODS

Location and Climate: Studies were executed at the department of Physiology at Shambat located at 15° 36´N, 32° 35´ E and an altitude of 390 m. The prevailing climatic data were obtained from the meteorological centre at Shambat located 500 m. from the experiment site.

Animals: Nine healthy deserts ram aged 2.5-3years old and of 39.0-46.5 Kg were used. The experimental animals were divided into three groups (n=3) for each feeding level (high, medium and low). Animals were accommodated individually in separate well ventilated and shaded pens with the facilities of feeding and drinking. All rams were clinically examined for general health condition and a massive protocol of health control, including deworming and sanitary measures, were performed. Dry lucerene hay (*Meicago sativa*) (CP:17.5%; ME:8.48MJ/kg), was prepared by drying fresh materials under the sun and then chopped and mixed thoroughly before feeding.

Experimental Procedure: All experimental animals were kept for adaptation for 2 weeks during which they were offered dry lucerene hay (*Meicago sativa*) and clean tap water *adlibitum* followed by an experimental period of 12 weeks during summer and winter seasons. The same protocol for the calculation and feeding of different (high, medium and low) levels of chopped lucerne hay (*Medicago sativa*) [6] was performed during the experimental period with free access to clean tap water.

Measurements and Blood Sample Collection: In each season, rectal temperature (Tr) was measured twice daily in the morning and in the afternoon and blood samples were collected weekly for 3 months [6].

Blood Analysis: Haemolysis free serum samples were used for the determination of total protein, albumin and urea level and plasma for glucose concentration [6, 21].

Statistical Analysis: The effects of feed restriction and seasonal changes on the circadian rhythm of rectal temperature and blood metabolites were evaluated by two way ANOVA [22]. The results obtained were presented as means ± S.E.

RESULTS AND DISCUSSION

The ambient temperature and relative humidity values were higher during summer compared to the respective values reported for winter season (Table 2).

The diurnal change in rectal temperature (DTr) observed in all experimental groups in both summer ($p< 0.01$) and winter ($p< 0.05$) (Table 3) is associated with the circadian changes in thermal environment. Also this DTr could be attributed to the higher values of Tr reported in all groups of rams during summer compared to winter [6]. Piccione and Caola [23] reported that, the circadian rhythm of body temperature reflects the adaptation of animals to changes in external environmental temperature. The DTr of Desert rams was more pronounced with the low plane of nutrition irrespective of the season (Table 3). This response could be related to low metabolic rate of feed restricted rams associated with low heat production. The mean diurnal change in ambient temperature reported during the experimental period was 15.75°C during winter and 12.66°C during summer (Table 2). This change in ambient temperature influenced body temperature of rams. Da silva and Minomo [24] indicated that, limited DTr of Corriedale rams in the tropics during summer (0.42°C) and winter (0.46°C) were closely related to the prevailing ambient temperature. Previous studies reported circadian rhythm in rectal temperature in response to ambient temperature [25, 26].

The rams maintained on low level of feeding showed significantly ($p< 0.05$) lower values of serum total protein (STP) concentration during winter compared to summer values (Table 4). Swenson [27] indicated that the synthesis of plasma proteins is markedly reduced when the supply of amino acids for digestive process is not adequate. Similar results were recorded in feed restricted Merino rams [28] and in animals fed low level of lucerne hay [29, 30] where low levels of total plasma protein were reported.

The significantly($p< 0.05$) lower serum albumin concentration (SAB) obtained with feed restriction in both seasons in Desert rams (Table 4) is clearly associated with the low amount of lucerne hay consumed

Table 1: The chemical composition of the feeds (%) on dry matter basis

	Lucerne (*Medicago sativa*)	Abu Sabien (*Sorghum vulgare*)
Dry matter	23.00	10.00
Metabolizable energy (MJ/kg)	8.48	8.96
Crude fibre (%)	30.00	38.60
Crude protein (%)	17.50	6.85
Ether extract (%)	0.99	3.00
Nitrogen free extract (%)	40.27	40.00
Ash (%)	11.57	8.52

Table 2: The mean values of ambient temperature Ta (°C) and relative humidity, RH (%) during the experimental period

	Ta (°C)			
Season	Max.	Min.	Mean	RH (%) (Mean)
Winter	31.58±1.51	15.83±1.66	23.71±7.88	28.17±4.57
Summer	38.23±2.61	25.59±1.18	31.91±6.32	42.09±11.49

Table 3: Effects of level of feeding lucerne hay and season on the diurnal pattern of rectal temperature, Tr (°C) of Desert rams (n = 252, mean ± S.E.M.)

Level of feeding	Season	7:00 a.m.	2:00 p.m.	SL
High	Summer	38.12^{b}±0.02	39.103^{a}±0.05	***
	Winter	37.98^{b}± 0.04	38.72^{a}±0.03	**
Medium	Summer	37.89^{b}±0.04	38.99^{a}±0.06	***
	Winter	37.74^{b}±0.05	38.64^{a}±0.04	**
Low	Summer	37.54^{b}±0.10	38.76^{a}±0.05	***
	Winter	37.40^{b}±0.06	38.39^{a}±0.04	***

Table 4: Effects of feed restriction and seasonal change on blood metabolites of Desert Rams (n=36)

	Blood parameters/Season							
	Total protein con. (g/dl)		Albumin conc. (g/dl)		Urea conc. (mg/dl)		Glucose conc. (mg/dl)	
Level of feeding	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
High	7.84^{Aa}±1.96	7.46^{Ab}±0.10	3.57^{Aa}±0.04	3.45^{Ab}±0.04	22.94^{Aa}±1.11	25.46^{Aa}±1.34	64.91^{Aa}±2.96	67.20^{Aa}±1.63
Medium	7.51^{Ba}±0.10	7.43^{Aa}±0.13	3.50^{Ba}±0.04	3.37^{Bb}±0.05	21.38^{Aa}±0.94	25.12^{Aa}±1.51	62.18^{Aa}±2.55	62.01^{Aa}±1.38
Low	7.33^{Ba}±0.12	7.45^{Aa}±0.14	3.54^{ABa}±0.04	3.38^{Bb}±0.05	19.59^{Ab}±0.71	24.59^{Aa}±1.41	59.74^{Aa}±2.71	61.62^{Aa}±1.59

Values (mean ± SE), for each parameter, with different lower case letters in the same row and with different upper case letters in the same Column differ significantly ($P < 0.05$)

and consequently the amount of protein intake. The current results are consistent with the findings reported a reduction in plasma albumin level in feed restricted ruminants under wet summer [29] and dry summer condition [30]. However, the significantly ($p < 0.05$) low level of SAB observed during summer with all levels of feeding compared to winter values (Table 4), could be related to the low intake of lucerne hay during summer compared to winter. The response could also be associated with an increase in water consumption during summer and development of haemodilution [31].

The serum urea (SU) level was significantly ($p < 0.05$) higher during summer compared to winter values in rams fed low level of lucerne hay (Table 4). This response could be related to low water intake. Previous studies have reported a positive correlation between water intake and dry matter intake in sheep [32] and a decrease in urinary nitrogen excretion during water restriction [33, 30]. Furthermore, the restriction of food intake could have been associated with recycling of urea and reduction in urinary excretion. Ruminants are capable of maintaining the level of blood urea during the dry season with scanty food by urea recycling [34]. Bunting *et al.* [35] reported an inverse relationship between the level of protein intake and the amount of blood urea nitrogen entering the rumen. Also Farid [19] attributed the reduction in urinary nitrogen excretion in feed restricted Barki rams to the improved utilization of digested nitrogen.

In both seasons, the plasma glucose level(PLG) showed a slightly consistent decrease with feed restriction (Table 4). This finding could be attributed to the low amount of protein intake as a proportion of glucose is derived from amino acids by gluconeogenesis [36]. Also this response, could be related to decrease in availability of nutrients and lower rate of production of propionate which is known to be the main precursor of glucose in ruminants [37]. In ruminants, propionate is the most important glucose precursor obtained by microbial fermentation of carbohydrates [38]. Moreover, when the glucose supply is limited, mobilization of body energy stores for glucose synthesis (and oxidation of spare glucose) will maintain constant level of blood glucose [39]. Sheep are characterized by their efficient utilization of glucose and the diurnal pattern in its concentration [5]. Also this response is related to the continuous absorption of glucose and slow passage of food in the alimentary tract of sheep [40]. Hypoglycaeamia was reported in Suffolk wethers fed on sub-maintenance energy allowance [41]. The slight increase observed in PLG in feed restricted rams (Table 4), could be related to seasonal changes in thermal environment which may influence carbohydrate metabolism and glucose kinetics. An increase in blood glucose concentration during summer was reported [42].

The seasonal and thermal fluctuations in environment may induce marked changes in the physiological responses of sheep. Accordingly, more studies are needed to elaborate their impacts on the diurnal changes in haematological parameters, blood metabolites and hormone secretion in Desert sheep, which may influence their productive and reproductive performance.

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