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Dynamics of environment: The modulation of serum metabolites and electrolytes in Sirohi goat

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Abstract

The present investigation was designed to evaluate the impact of hot ambience on serum electrolytes and metabolites concentration viz. sodium (meq/l), potassium (meq/l), chloride (meq/l), serum cholesterol (mg %), glucose (mg/dl), creatinine (mg %) and total serum protein (g/dl). During hot ambience the mean values of sodium, chloride, serum cholesterol, glucose and creatinine levels were increased significantly ($P < 0.05$) than mean values of respective moderate ambience while the mean value of potassium and total serum protein levels were decreased significantly ($P < 0.05$) than moderate ambience. Thus, it could be concluded that changes in environment may cause the large-scale alterations in animal physiology. It can be suggested that animals must be protected from extreme environments and require preconditioning before the long possible exposure to environmental extremes.

Keywords: Heat stress, goat, serum electrolytes, serum metabolites

Introduction

Goat husbandry is the vital occupation of villagers because it may survive even on minimum expense value, that's why it is also known as 'poor man's cow'. Heat, cold, dehydration, crowding, regrouping, noise, confinement, trauma, transportation, infections etc. are the common agents of stress experienced by the goats. When the pressure caused by stressor becomes excessive, or in case of psychological threat, new defence mechanisms are initiated, collectively referred to as stress responses. Recent researches indicate that during extreme high environmental temperature, internal homeostasis is changed causing change in working efficiency of organs, which can be represented in terms of reduced metabolism and growth. The variations in physiological parameters are indicative of stress during heat which directly or indirectly affects the performance. In extreme heat condition, the loss of water and electrolytes causes dehydration as well as change in metabolic production, which further worsens the condition and causes economic loss to poor farmers in terms of weight loss, poor growth performance and reproduction efficiency. Due to heat stress, metabolism of individual may change to accommodate the body according to the environmental changes. The determination of values of serum metabolites and electrolytes reflects the physiological status of affected animal, which is helpful in direct intervention.

Materials and Methods

To investigate the impact of hot ambience the whole experiment was divided into two periods of extreme hot and moderate environmental temperature periods (ETPs). The months of May and June were considered as extreme hot (Average environmental temperature 26-44 °C) and of October and November (Average environmental temperature 19-30 °C) were considered as moderate environmental temperature periods. In each ETP, blood samples were collected according to male and female sex groups, in first group blood samples were collected from 1 year to 4 years age group male (40) and non-pregnant female (40) animals. To assess the effect of extreme environmental temperature, the results of various physiological parameters analysed were compared with those analysed during moderate serving as control periods. Environmental impact was assessed by measuring important environmental elements from the area. All efforts were made to analyse serum samples immediately, however, if needed, collected serum samples were stored in a deep freeze at -20 °C till analysis. During experiment the serum sodium, potassium and chloride levels were estimated by colorimeter method of end point assay (SP twin electrolytes test kit) while the serum

cholesterol (mg %), glucose (mg/dl), creatinine (mg %) and total serum protein (g/dl) were determined by standard manual methods of Sackett, Folin-WU, Picrate and Biuret method.

The statistical method of t-test was used for data analysis with Microsoft excel software and SPSS software.

Results and Discussion

The mean values of serum sodium, potassium, chloride, serum cholesterol, glucose, creatinine and total serum protein during moderate and hot ambience in male and female *Sirohi* goats are presented in table 1 and 2, respectively.

Effect of moderate ambience on serum sodium, potassium and chloride in *Sirohi* goats

In the present investigation the mean values of serum sodium and potassium obtained during moderate ambience were more

or less similar to numerical values as determined by Daramola *et al.* (2005) [11], Sandabe and Chaudhary (2000) [39], Waziri *et al.* (2010) [40], Aiello (2000) [4] and Okoruwa and Ikhimioya (2014) [28]. The mean value of serum chloride was approximately similar as determined by Kalio *et al.* (2013) [21] and Pandey *et al.* (2006) [34].

Effect of hot ambience on serum sodium, potassium and chloride in *Sirohi* goats

During hot ambience the serum sodium, and chloride levels were significantly ($P < 0.05$) increased, while the serum potassium level was significantly ($P < 0.05$) decreased in *Sirohi* goats. The finding of present study of sodium, potassium and chloride levels were almost similar to as reported by Abdel-Fattah (2014) [1] and Hooda and Upadhyay (2014) [19].

Table 1: The comparison of serum sodium, potassium and chloride (Mean \pm SEM) in male and female *Sirohi* goats during moderate and hot ambience

Effect	Sodium (meq/l)		Potassium (meq/l)		Chloride (meq/l)	
	Male	Female	Male	Female	Male	Female
Moderate	143.275 \pm 3.21	135.020 \pm 2.41	5.097 \pm 0.24	4.426 \pm 0.18	111.347 \pm 2.19	101.977 \pm 2.89
Hot	151.793 ^d \pm 2.61	143.345 ^d \pm 2.64	4.235 ^d \pm 0.14	3.760 ^d \pm 0.16	119.843 ^d \pm 2.44	110.703 ^d \pm 3.03

- Figures in parentheses indicate number of male and female goats.
- The mean value of parameters in extreme hot ambience has been compared with the respective mean value in moderate ambience.
- Significant ($P < 0.05$) variations have been shown by using superscript 'd'.

Increased concentration of sodium during hot ambience could be due to oxidative stress and changes in mechanism of body, Kataria *et al.* (2002) [23]. An increased plasma sodium concentration during heat exposure stimulates vasopressin secretion and thirst which leads to enlarged plasma volume, Olsson (2005) [31]. El-Nouty *et al.* (1980) [12] reported that decreased concentration of potassium in cow blood serum during prolonged heat stress was due to loss of potassium ion in sweat. It is suggested that during heat stress potassium excretion is increased due to increased aldosterone in dairy cattle. The increased potassium ion concentration was correlated with stress induced activation of cortisol secretion which also caused stimulation of gluconeogenesis, Marai *et al.* (2007) [25]. The low serum sodium during hot season could be due to physiological adaptation while reduced serum potassium concentration during hot ambience was due to dehydration, Azabe and Abedl Maksoud (1999) [7]. Chloride is one of the important biochemical parameter used to detect homeostatic mechanism. In the body chloride follows sodium ions in maintenance of acid base balance; during hot ambience Renin-Angiotensin-Aldosterone-System mechanism affects chloride absorption along with sodium ions, Halevy *et al.* (1986) [16]. The decrease in serum electrolyte concentration during hot ambience may be due to expanded blood volume where water is transported in the circulatory system for evaporative cooling as suggested by Al-Haidary (2004) [6].

The increase in serum chloride level may be the result of water loss from plasma. Kataria *et al.* (2002) [23] reported that during dehydration condition, aldosterone is mainly responsible to retain water, sodium and chloride ion and to secrete potassium ion in kidney.

Serum concentration of glucose, cholesterol, creatinine and total serum protein in *Sirohi* goats during Moderate ambience

In the present investigation the mean value of serum glucose obtained during moderate ambience was more or less similar to numerical value as determined by Rodostits *et al.* (2002) [35], Abdel-Fattah *et al.* (2014) [1], Okoruwa (2014) [29] and Carlos *et al.* (2015) [10]. The mean values of serum creatinine and cholesterol were similar than as reported by Opera *et al.* (2010) [32], Olafadehan (2011) [30] and Babe *et al.* (2015) [8]. The finding of present study of total serum protein obtained during moderate ambience was more or less similar to numerical value as determined by Abdelatif *et al.* (2009) [2] and Addass *et al.* (2010) [3].

Effect of hot ambience on serum concentration of glucose, cholesterol creatinine and total serum protein in *Sirohi* goats

During hot ambience the serum glucose, cholesterol and creatinine were increased significantly ($P < 0.05$) in male as well as female goats but total serum protein level was decreased significantly ($P < 0.05$) in male as well as in female goats. The serum glucose, cholesterol and creatinine levels were almost similar to as reported by Kaliber *et al.* (2015) [20], Pandey *et al.* (2012) [33], Helal *et al.* (2010) [17] and Sharma and Puri (2013) [38]. The total serum protein level was almost similar to as reported by Gupta *et al.* (2013) [14] and AL-Eissa *et al.* (2012) [5].

Table 2: The comparison of serum glucose, cholesterol creatinine and total serum protein (Mean \pm SEM) in male and female *Sirohi* goats during moderate and hot ambience

Effect	Glucose (mg/dl)		Cholesterol (mg%)		Creatinine (mg%)		Total Serum Protein (g/dl)	
	Male	Female	Male	Female	Male	Female	Male	Female
Moderate	63.668 \pm 1.79	52.439 \pm 2.32	111.5 \pm 5.35	138.00 \pm 7.57	1.362 \pm 0.09	1.10 \pm 0.08	7.170 \pm 0.21	6.578 \pm 0.11
Hot	69.598 ^d \pm 1.29	62.663 ^d \pm 1.35	94.285 ^d \pm 5.71	115.713 ^d \pm 5.78	1.725 ^d \pm 0.11	1.387 ^d \pm 0.10	6.519 ^d \pm 0.16	6.012 ^d \pm 0.16

- i) Figures in parentheses indicate number of male and female goats.
- ii) The mean value of parameters in extreme hot ambience has been compared with the respective mean value in moderate ambience.
- iii) Significant ($P < 0.05$) variations have been shown by using superscript 'd'.

Blood glucose level was increased in hot ambience, which could be correlated with that of endocrine response of animals that is the activation of hypothalamo-pituitary-adrenal-axis and secretion of cortisol, Kannon *et al.* (2000) [22]. The decreased level of blood glucose is mainly due to feed restriction during heat stress, Hooda & Upadhyay (2014) [19], Hooda and Naqvi, (1990) [18], Ocak and Guey (2010) [27] and Sejian and Srivastava (2010) [37]. During heat stress feed intake is reduced which causes the lower serum glucose level, Kataria *et al.* (2002) [23], Russella *et al.* (2002) [36] stated that glucose derived oxidative stress plays important role, along with physio-pathogenic mechanisms. Increase in plasma glucose during hot condition may be due to decrease in glucose utilization and reduced secretion of catabolic and anabolic enzymes as well as reduced basal metabolic rate (BMR). Changes in glucose concentration may be associated with changes in the plasma concentration of blood glucose and collection sites can also provide different measures of glucose concentration, Kuwa *et al.* (2001) [24]. Female goats excrete less creatinine than male goats because of their smaller muscle mass Ganong (2005) [13]. Decrease in concentration of serum cholesterol with increased environmental temperature may be due to dilution as a result to the increased total body water concentration or due to the decrease in acetate concentration, which is the primary precursor for the synthesis of cholesterol Habeeb *et al.* (1996) [15]. During heat stress restricted feed intake may cause impaired protein synthesis because of inadequate amino acid supply from digestive tract, Mohammad (2012) [26]. Another reason of lowered plasma protein could be hemodilution caused by increase in water consumption, Bernabucci *et al.* (2010) [9]. In different studies on goats, the fluctuation in serum metabolites concentration were observed, which may be due to feeding habits, management aspect, minor reproduction and various physical and physiological parameters.

Conclusion

On the basis of present study it can be proposed that heat stress poorly affect the homeostasis of goats. The pattern of variations in serum electrolytes and metabolites enlightened the same. So all safety tools must be taken to protect the animals from the long of extreme ambiences along with that elemental preconditioning is also suggested.

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