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Effect of seasonal stress on cortisol level of goats

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Abstract
Present study in goat (Capra *hircus*) was conducted to identify the hormonal level during different seasons. Understanding the seasonal patterns of thermoregulation in caprine is crucial to develop the efficient livestock in the subtropics. Thus, the aim of the current research was to evaluate the level of adaptation by change in hormonal profile during different seasons in goats. The study was conducted on indigenous goats (N=30) to investigate the hormonal profile. The significant ($p< 0.05$) rise in the physiological reactions occurred in goats during summer showing a positive correlation with the temperature and physiological responses so as to overcome the environment stress during different summer of animals. The variations in blood hormonal components observed in the goats during summer seasons depicting its thermotolerance. The significant ($p< 0.05$) increase in cortisol concentrations was high during summer showing a direct relationship with efficient water balancing mechanism in the body. Plasma cortisol concentration increased significantly in winter and summer season but within normal range in control (spring).The higher concentration of plasma cortisol level in summer is mainly due to cope up with stress conditions and to maintain homeostasis through various actions.

Keywords: Seasonal, stress, cortisol, goats, hormonal

Introduction
India occupies first position in terms of goat population and milk production. Chevon (goat meat) is most preferred and widely consumed meat in the country reported by Livestock Production Statistics of India – 2018. Since ancient times goat milk has traditionally been known for its medicinal properties and has recently gained importance in human health due to its proximity to human milk for easy digestibility and health promoting traits. Still research is needed to explore and validate medicinal properties of goat milk for projecting it as therapeutic milk for human health. Demand for goat milk and milk products for internal consumption and export is expected to rise in coming years. Goat husbandry provides glimpses of future hope for employment generation, nutritional security and prosperity to the millions of small and marginal farmers in the country (FAO 2015) [5].

Among all species of farm animals, Goats converts low quality feed materials to high quality proteins. Goats are efficient browsers and prefer eating brushy plants along with some other woody and weedy plants found on the ranges. Goats are able to digest a large variety of fibre and roughage. Goats have the widest ecological range and have been poor people most reliable livelihood resource since their domestication during Neolithic Revolution about 10 millennia ago. Goat plays a significant role in providing supplementary income and livelihood to millions of resource poor farmers and landless labourers of rural India. Small ruminant rearing ensures self-employment and acts as a cushion in distress situations like drought and famine (Mlambo and Mapiye 2015) [12].

Performance of the livestock is influenced by several factors including the type of production systems, breed, age, sex, nutritional level, hormonal status, and environment (Habibu *et al.*, 2016) [6]. The agro-ecological zone as described by temperature, rainfall, topography, and vegetation is found to be a significant source of variation for animal production (Mpofu *et al.*, 2017) [13]. Livestock having superior productive traits may produce poorly when the environment is not favourable due to negative interaction between their genetic merit and environmental variables (Mpofu *et al.*, 2017) [13].

The serum cortisol concentration profiles indicated stress level of the animal and seasonal variation is detected in daily cortisol secretion patterns. During heat and cold stress there is significant increase in cortisol level. Although the possible circadian variation of cortisol secretion in goats is completely masked by external factors, and the lighting conditions do not have immediate effects on the daily secretion patterns (Johansson *et al.*, 2009) [7].

The seasonal variation in the overall cortisol levels is most probably related to the changes in photoperiod. The significant deviations in the level of cortisol which might be due to a metabolic shift in the stressed animals to cope with the imposed stress as cortisol plays an important role in all types of stress (Caroprese *et al.*, 2012; Sivakumar *et al.*, 2010) [4, 17].

Materials and Methods

Location and experimental period

The study was conducted at Karnal, India located at an altitude of 240 meters above the mean sea level and at 29°42'3" N latitude and 76°59'6" E longitude. The experiments were conducted in winter (December – January), spring/thermoneutral (March) and summer (May) seasons with an average Temperature-Humidity Index (THI) of 59.27, 70.97 and 84, respectively. The Temperature Humidity Index (THI) was calculated by using the equation of THI= 0.72 x (Cdb + Cwb) + 40.6 (Mc Dowell, 1976) [11], where, Cdb = Average dry bulb (°C), Cwb = Average wet bulb (°C).

Table 1: Environmental parameters in different seasons during the experimental days

Season	Months	Temperature (°C)		Dry bulb		Wet bulb		THI
		Maximum	Minimum	1	2	1	2	
Winter	Dec-Jan	±21.1	10.8	13.25	19.3	8.25	18.1	61.80
TNZ	March	±27.4	20.7	23.4	27.0	18.4	21.6	73.14
Summer	May	±40.1	33.7	35.2	40.1	27.6	31.4	88.94

Animals and sampling

The blood samples for the study were collected from National Dairy Research Institute situated at Karnal from ten numbers (n=10) of male goats of 2-3 years of age and average body weight of 28.8 ± 0.7, 27.15 ± 0.55 and 27.91 ± 0.82 kg respectively, each during winter (cold), spring (thermoneutral) and summer (hot) seasons. The Cortisol concentration in the plasma samples were estimated by using Goat Cortisol ELISA kit, catalogue no. E0021Go, 96 tests from Bioassay Technology Laboratory. This kit is a sandwich enzyme immunoassay used for the quantitative measurement of Cortisol (COR) in Goat's serum or plasma. This kit uses Enzyme- Linked Immunosorbent Assay (ELISA). COR is added to the wells precoated with COR monoclonal antibody. After incubation a biotin- conjugated anti- Goat COR antibody is added and binds to Goat COR. After incubation unbound biotin-conjugated anti-Goat COR antibody is washed away during a washing step. Streptavidin- HRP is added and binds to the biotin-conjugated anti- Goat COR antibody. After incubation unbound Streptavidin- HRP is washed during a washing step. Substrate solution is then added and colour develops in proportion to the amount of Goat COR. The reaction is terminated by the addition of acidic stop solution and absorbance is measured at 450nm.

Statistical analysis

All the statistical analysis was carried out to find Mean ± S.E.M. One-way ANOVA was done to find out the significant difference between seasons.

Results and Discussion

The present study was conducted in goat (*Capra hircus*) to identify of cortisol level in during different seasons.

Cortisol (ng/ml)

Mean ± S.E.M values of plasma cortisol level showed significant ($p< 0.05$) variation between levels in goats during different seasons are presented in table 2 and depicted in Fig.1. The average cortisol concentrations in plasma of the animals during winter, spring and summer were 5.14 ± 0.05, 4.92 ± 0.05 and 7.12 ± 0.08 ng/ml, respectively. Cortisol levels during winter was significantly ($P< 0.05$) lower than summer but higher than spring however there were significant difference when the concentrations during spring was compared to that of winter and summer. The average urea value of plasma was increased by 45.73% from spring to summer increase 38.52% from winter to summer and 4.47% increase from spring to winter.

The concentration of serum cortisol in cold and heat stress conditions was higher than thermoneutral temperatures. This finding was similar to those of Becker *et al.*, (1997) [3] in pigs and Nazifi *et al.*, (2003) [14] in fat tail sheep, who showed that the concentration of cortisol increased significantly during both extreme heat and cold thermal exposures, although the response was greater in the heat than in the cold it was suggested that high ambient temperature may have elevated glucocorticoid hormone. In this respect, Abilay *et al.*, (1975) [1] reported that plasma cortisol concentration showed a gradual increase in cattle exposed to acute thermal exposure. Similarly, Wise *et al.*, (1988) [18] reported that serum cortisol concentration was significantly higher in heat-stressed cows than in cows under air conditioning. Also, Kaushish *et al.*, (1997) [9] reported that the increase in cortisol level during heat stress was significant in goats. In contrast to the above reports, Salem *et al.*, (1991) [16] reported that in sheep the mean value for cortisol was significantly higher in winter than in summer, because in cold stress conditions cortisol had a significant negative correlation with serum cholesterol. The effect of cortisol on fat metabolism is an increase in cholesterol catabolism and serum concentration of free fatty acids. Hence, the significant correlation between serum cortisol and cholesterol is logical. Ashutosh *et al.*, (2001) [2] reported that in Indian native sheep the concentration of serum cortisol showed maximal increase during summer than the spring.

Cortisol plays an important role in all types of stress as it is a classic endocrine response to stress (Kannon *et al.*, 2000) [8]. It is used as an indicator of animal welfare, since its level increases during times of distress. A significant increase of cortisol in affected goats was well documented and our results coincided with earlier works (Caroprese *et al.*, 2012; Sivakumar *et al.*, 2010) [4, 17]. It is indicated that there were significant deviations in the levels of blood biochemical which might be due to a metabolic shift in the stressed animals to cope with the imposed stress reported by Noura El-Shahat Attia in 2016 [15].

Table 2: Mean ± S.E.M. values of serum cortisol levels of goats during different seasons

Parameter	Winter	Spring	Summer
Cortisol (ng/ml)	5.14^{b} ± 0.051	4.9^{c} ± 0.50	7.12^{a}± 0.08

Means with different superscripts (a, b and c) within same rows differ significantly ($P< 0.05$)

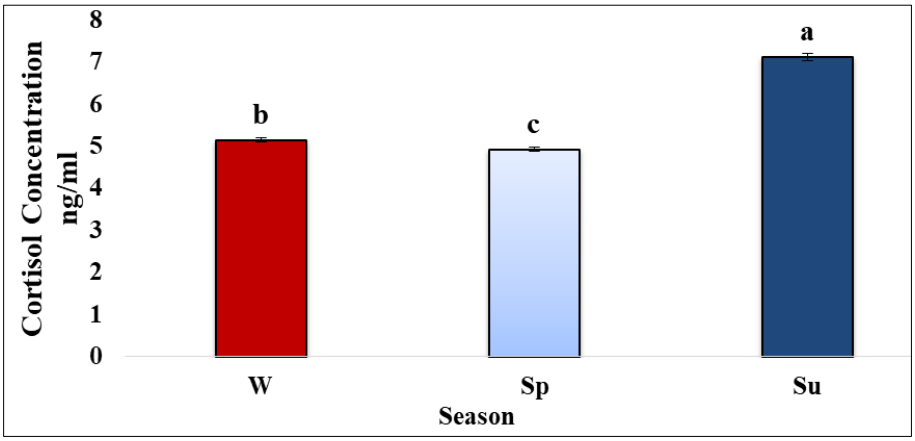

Fig 1: (Mean ± SEM) values of Plasma Cortisol concentration in goats during different seasons. Bars with different alphabets differ significantly (P<0.05). W= winter, Sp = spring and Su = Summer Season

Conclusion

Cortisol plays an important role in all types of stress due to its classic endocrine response to stress. Cortisol level increases during times of distress and various studies suggested that there is seasonal variation in endocrine profile of goats on account of varying degrees of homeostasis responses, and it may be regulated by associated changes in physiological, electrolyte related with body fluid metabolism in goats. It is reported that the concentration of serum cortisol in cold and heat stress conditions is higher than thermoneutral temperatures. In present study, the concentration of cortisol increased significantly during both extreme heat and cold thermal exposures and increase in cortisol level during heat stress was significant in goats, which influence the performance of the goat.

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