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Seasonal Variation in Serum Biochemical, Electrolyte and Hormonal Profile of Deoni Cattle

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Abstract

The present study was designed to understand the impact of season on biochemical, and hormonal parameters in Deoni cow. Study period comprises winter, spring and summer. Ambient temperature and relative humidity were recorded from sensor based automatic weather station and temperature relative humidity index (THI) was calculated. Blood samples were collected two times in each season from eight selected animals. Biochemical parameters were estimated using semi-automated biochemistry analyzer. The hormonal parameters were estimated by radio immune assay technique. The glucose, protein, triglycerides, cholesterol and creatinine were significantly ($P \leq 0.05$) lower in summer season. Significantly higher BUN and lower sodium and potassium were noticed in summer. Tri-iodothyronine and thyroxin were significantly higher in winter and lowest in summer. The cortisol concentration was higher in summer and lower in spring season. Exposing animals to higher thermal load leads to changes in the biochemical and hormonal profile to maintain normal physiological process.

Keywords: Biochemistry, Deoni, Hormones, Seasons, Stress

Introduction

Seasonal variations in the environmental parameters leads stress and have measurable effects on the physiological, metabolic and endocrine profile of animals there by decreases the production performance. Metabolic hormones, such as thyroxine and triiodothyronine can be used to indicate metabolic changes in relation to altered feed intake during different seasons. Plasma cortisol concentration has been widely used as physiological markers of stress (Ganaie *et al.,* 2013). In general, the zebu cattle (*Bos indicus*) have higher degree of thermo tolerance compared with temperate cattle (*Bos taurus*) due to lower metabolic rate and greater sweating capacity (Blackshaw and Blackshaw, 1994; Hansen, 2004). Deoni is an important dual-purpose cattle breed of India. These animals are mainly found in Marathwada region of Maharashtra, Bidar district of Karnataka, and some parts of Telangana. Deoni cattle are hardy and well adapted to their breeding tract constituting an important cattle genetic resource in these regions (Singh *et al.,* 2002). Research is needed to evaluate the physiological performance, biochemical and hormonal status of Deoni cows under local climatic conditions, so that the patterns of responses to climatic stress can be established. The information obtained can be utilized in adopting managemental practices and nutritional strategies that can alleviate stress and improve reproductive performance, milk yield and to monitor the health status of Deoni cows. So, present work is designed to establish the baseline date of biochemical and hormonal profile of indigenous dual purpose Deoni breed in different seasons.

Materials and Methods

This study was carried out at Livestock Research and Information Centre (Deoni), Hallikhed, Bidar, of Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, Karnataka, India. The experiment was conducted for a period of six months comprising of three seasons which included winter (Dec-Jan), spring (Feb-Mar) and summer (April-May). Environmental parameters like the ambient temperature and relative humidity were recorded from sensor based automatic weather station and temperature relative humidity index (THI) of different seasons was calculated to know the stress level.

Eight Deoni cows (2months post-partum) with an average age of 3-4 years and average body weight of 325-350 kg were selected for the experimental study. Blood samples were collected from jugular vein, two times in each season from all the animals for estimation of biochemical parameters. Biochemical and electrolyte parameters were analyzed immediately after separation of serum where as for the estimation of hormones serum sample was stored at -20^{0}C until the analysis was carried out. The serum glucose, total protein, albumin, triglycerides, cholesterol, creatinine and blood urea nitrogen were estimated using semi-automated biochemistry analyzer (ARTOS®) by Swemed Biomedials Pvt. Ltd using SWEMED® Diagnostic Kits**,** Bangalore following the instructions and procedure supplied with the diagnostic kits. Serum concentrations of electrolytes viz., sodium and potassium were estimated by automated ion selective electrode-based electrolyte analyzer (LABLYTE™, Trivitron Health Care Ltd, Chennai).

The hormonal parameters viz., tri-iodothyronine (T_3), thyroxin (T_4) and cortisol were estimated by radio immune assay (RIA) technique by using a multi well gamma counter PC- RIA.MAS (STRSTEC) which is calibrated for I^{125} using RIA kits (BECKMAN COULTER) at National Institute of Animal Nutrition and Physiology, Adugodi, Bengaluru. The data obtained from the present study subjected to statistical analysis using one-way ANOVA as per the standard procedure described by Snedecor and Cochran (1994).

Result and Discussion

The local climatic parameters and temperature humidity index of the study period is presented in Table 1. It was noticed that the mean THI during the summer was highest (82.4) as compared to spring (73.3) and winter (66.9). Temperature-humidity index of 72 or less is considered cool and comfortable, 75-78 moderate stress and values greater than 78 cause extreme stress (Armstrong, 1994). Therefore, the climatic data indicate that the experimental cows were exposed to higher thermal load during summer and animals were with comfortable thermal load during winter and spring seasons under this study. The glucose concentration was significantly ($P \leq 0.05$) higher in winter and spring season as compared to summer indicating negative effect of heat stress on blood glucose concentration. These findings are in agreement with the reports of Rasooli *et al.* (2004), Gupta *et al.* (2013), Das *et al.* (2014) and Hasin *et al.* (2019) who reported lower concentration of serum glucose during summer. Blood glucose concentration indicates energy status of dairy animals. The decrease in the glucose concentration during the summer could be due to the reduction in feed intake as a result of thermal stress and probably due to depletion of hepatic glycogen.

Table 1: Local climatic parameters during experimental period during winter, spring and summer

Season	Air Temperature(^{0}C)			Relative Humidity (%)			THI (%) (mean)
	Maximum	Minimum	Mean	Maximum	Minimum	Mean	
Winter	27.8 (20.9-31.6)	15.1 (9.7-20.0)	21.4	76.49 (44.94-100.00)	30.27 (14.94-76.98)	53.4	66.9
Spring	32.7 (28.6-33.6)	18.8 (14.8-18.8)	25.7	67.94 (46.73-97.40)	22.65 (9.63-49.35)	45.3	73.3
Summer	39.64 (31.9-43.0)	24.3 (20.3-28.9)	31.3	63.73 (33.86-90.56)	18.95 (10.60-35.84)	41.3	82.4

The total protein concentration was lower during summer season as compared to winter and spring season. Total protein content is usually used as an indicator of animals' nutritive status reflecting food intake and metabolism (Serdaru *et al.,* 2011). Heat stress during summer inhibits appetite centre via satiety centre to reduce feed intake as one of the thermoregulatory mechanisms to reduce metabolic heat production. These findings are in contrast to the findings of Rasooli *et al.* (2004), Shrikhande *et al.* (2008) and Das *et al.* (2014) who reported higher total protein concentration during summer. These workers concluded that the animals suffer from severe dehydration at high ambient temperature which leads to elevation of total protein concentration in blood. There was no significant ($P \leq 0.05$) difference in the albumin concentration between different seasons but observed higher values in winter and spring than summer maybe due to higher levels of feeding. These results are similar to the findings of Yadav *et al.* (2001) who reported that although total protein level increased during summer, the albumin fraction is unaffected by season. Contrary to these results Das *et al.* (2014) have reported higher albumin concentration during summer.

Significantly ($P \leq 0.05$) lower concentrations of triglycerides were noticed in summer as compared to winter and spring seasons. These results are in agreement with the results of Nardone *et al.* (1997) and Alameen and Abdelatif (2012). The decrease in the triglycerides during summer may be attributed mainly for decrease in voluntary food intake by the animals in hot climatic conditions. Serum cholesterol was significantly ($P \leq 0.05$) lower in summer as compared to winter and spring. These results are in conformity with the findings of Rasooli *et al.* (2004) and Alameen and Abdelatif (2012). Abeni *et al.* (2007) who observed reduction in plasma levels of cholesterol and triglycerides in Friesian cows during the hotter season and attributed that to increase in lipid mobilization by peripheral tissues. A reduction in liver activity reported during heat exposure (Ronchi *et al.,* 2001) could also explain the lower cholesterol level during summer. In contrast Sinha *et al.* (1981) observed higher concentration of cholesterol in cattle during summer than other seasons.

Wide variation in the creatinine concentration during different seasons was recorded which is lower in summer as compared to winter and spring. These results are in agreement with the work of Haidar *et al.* (2009) who have reported significantly higher level of creatinine in the winter season than in the summer season in cattle. In contrast, Ronchi *et al.* (2001) recorded increased creatinine in blood during heat stress. They are of the opinion that increased creatinine during hot environmental condition is because of excess muscular catabolism for energy supply in Holstein cows. The mean values of blood urea nitrogen was significantly ($P \leq 0.05$) higher in summer as compared to winter and spring. These results corroborate the findings of Ronchi *et al.* (2001) in Holstein cows, Rasooli *et al.* (2004) in HF heifers and Khan *et al.* (2011) in Murrah buffaloes. The apparent summer hike of BUN could be due to increased catabolism of amino acids for energy (Abeni *et al.,* 2007). Some of these amino acids could be derived from the protein mobilization of muscle tissue, which also support increase in the level of BUN observed during summer season. Silanikove (2000) related the increase in urea level to increase in the level of cortisol which induces catabolism of body proteins. The mean serum concentration of Na^+ and K^+ were significantly lower in summer as compared to winter and spring. El Nouty *et al.* (1980) documented the simultaneous relationship among thermal stress, plasma aldosterone level and urine electrolyte concentration in bovines. During prolonged heat exposure plasma aldosterone level was reported to decline. Concurrent with this, there were significant fall in serum and urinary K^+ was noticed by Shrikhande *et al.* (2008). Coppock *et al.* (1982) reported that enhanced heat dissipation during heat stress may also lead to electrolyte losses through sweat, saliva, polypnea and urine. This may lead to fall in plasma Na^+, K^+ and Cl^- concentration.

Table 2: Biochemical parameters and electrolytes levels during different seasons in Deoni cattle

Parameter	Winter	Spring	Summer
Glucose (mg/dL)	49.64±0.84[a]	48.18±0.95[a]	45.44±0.59[b]
Total protein(g/dL)	8.15±0.14[a]	8.19±0.21[b]	7.29±0.14[b]
Albumin (g/dL)	4.38±0.09	4.29±0.07	4.10±0.06
Triglycerides(mg/dL)	39.40±0.31[a]	38.40±0.24[a]	36.07±0.46[b]
Cholesterol (mg/dL)	62.84±0.49[a]	61.38±0.27[a]	59.46±0.52[b]
Creatinine (mg/dL)	1.53±0.55[a]	1.79±0.06[b]	1.89±0.13[b]
Blood urea nitrogen (mg/dL)	22.29±0.84[a]	23.09±0.61[a]	29.89±0.52[b]
Sodium (mMol/L)	139.16±0.90[a]	138.50±1.04[a]	135.46±0.41[b]
Potassium (mMol/L)	4.55±0.05[a]	4.48±0.10[ab]	4.30±0.08[b]

The mean values of T_3 and T_4 were significantly ($P \leq 0.05$) higher in winter as compared to spring and summer. Thyroid gland is one of the most sensitive organs to the ambient temperature. Seasonal variations in the concentration of serum T_4 and T_3 in have been reported by Rasooli *et al.* (2004) and Kalmath and Narayana Swamy (2019) in different indigenous species and breeds. Cold environment may be a stimulus to increase the thyrotrophic hormone output thereby resulting in a higher concentration of thyroid hormones in serum. It is believed that in hot environments, adaptive response is usually associated with decrease in food intake and metabolic heat production. Therefore, during summer heat acclimation and physiological adjustment by thermoregulatory centre induce a decrease in endogenous heat production influenced mainly by thyroid hormones (Bernabucci *et al.*, 2010). Hence the exposure of animals to the high environmental temperature during summer could have depressed the functional activity of thyroid gland and thereby caused a relatively lower concentration of thyroid hormones. The mean cortisol level was significantly ($P \leq 0.05$) higher in summer followed by winter and the lowest was recorded during spring. This pattern indicates that Deoni cows were exposed to thermal stress during summer season. The rise in cortisol level during summer in the present study is in agreement with Bouraoui *et al.* (2002) and Ahmed and Abdalla (2012) who reported higher plasma cortisol level during summer. The blood cortisol level is generally considered as a reliable physiological index for determining animal response to stress, as indicated by assessment of glucocorticoid levels in cows under a variety of conditions. Certain environmental stressors have the potential to activate the hypothalamo-pituitary-adrenal cortical axis (HPA) and sympatho-adrenal medullary axis. Other researchers reported that glucocorticoid secretion was reduced in dairy cattle exposed to heat stress (Ronchi *et al.,* 2001).

Table 3: Tri-iodothyronine (T_3), Thyroxine (T_4) and Cortisol levels (Mean± SE) during different seasons in Deoni cattle

Parameter	Winter	Spring	Summer
Tri-iodothyronine (ng/ml)	0.82±0.01[a]	0.71±0.01[b]	0.63±0.01[c]
Thyroxine (ng/ml)	40.24±0.17[a]	38.07±0.23[b]	35.95±0.16[c]
Cortisol (ng/ml)	19.10±0.26[a]	16.63±0.10[b]	21.30v0.16[c]

Conclusion

In conclusion, the data indicate the need for metabolic profile monitoring in relation to season. Reasonable nutritional strategies and modifications of local thermal environment should be adopted in order to mitigate the negative effects of heat stress during summer to enhance the productive and reproductive performance in Deoni cattle.

Conflict of Interests

There is no conflict of interest.

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