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Effect of heat stress on biochemical parameters of dairy cows in Bengaluru region of Karnataka

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Abstract
An experiment was conducted to compare the effect of heat stress on biochemical parameters in dairy cattle, when different heat stress alleviating methods were employed. Twelve lactating dairy cows with similar body weight and production levels were selected and grouped into three treatments with four animals in each group. The treatments viz T1 as control, T2 (micro sprinklers) and T3 (wet gunny bags). Biochemical Parameters *viz;* serum cortisol (µg/dl) hormone and serum electrolytes (sodium and potassium) levels(mEq/L) were estimated on 0^{th}, 30^{th} and 60^{th} day for all the three treatment groups. The overall mean±SE values of serum cortisol levels of the experimental animals during study period for the group T_1 T_2 and T_3 were 0.92±0.07, 0.75±0.10 and 0.98±0.10, respectively. The statistical analysis revealed non-significant difference among treatment groups for serum cortisol levels. The overall mean±SE values of serum sodium (mEq/L) levels of the experimental animals during trial period for T_1, T_2 and T_3 were 144.27±0.03, 145.55±0.42and 145.15±0.06, respectively. The statistical analysis revealed non-significant difference in serum sodium levels, similarly the overall mean±SE values of serum potassium (mEq/L) levels for T_1, T_2 and T_3 was 4.22±0.10, 4.15±0.06 and 4.34±0.08, respectively. There was non-significant difference observed in serum potassium levels among all the treatment groups. The study indicates that the prevailing climatic condition in the study area showed non-significant effect on all the biochemical parameters, indicating that the environmental conditions might be conducive for livestock farming activities.

Keywords: Heat stress, biochemical parameters, dairy cows

1. Introduction
India is the prime producer of milk in the world and it was estimated that country has produced about 209 million tons of milk in the FY2021 from 198 million tons in FY2020.With increase in milk production; the per capita availability is projected to rise to 427 gm per day in financial year 2021. The thermal environment has immediate as well as long term adaptive influences on animals. Environment is a prime limiting factor in animal production. There are many factors *viz.*, radiation, convection, conduction, evaporation and precipitation involved in exchange of heat by animals and surrounding environment.

Hormones secreted from different endocrine glands are having major importance in thermoregulation and productivity of the animals. Due to prolonged heat exposure of the animals, hypothalamic releasing factors are suppressed. Numerous hormones that are depressed in tropics may warrant consideration as a means or restore milk yields of dairy cattle. The tropical country like India requires specialized management practices of dairy cattle under different agro climatic regions [2]. Summer and winter stress leads to severe changes in the blood biochemical and hormonal concentration there by decreases the production performance of the animals [6]. Cortisol is known as one of the most important hormones involved in the regulation of gluconeogenesis as well as in the regulation of carbohydrate and lipid metabolism. This fact is of great importance in high-yielding cows during high metabolic load periods such as late pregnancy and lactation [3]. Minerals are important as essential nutrients in the diet of animals. Physiological status might modify animal's requirement to these elements [1]. Due to global warming and climate change Bangalore has no excuse for this. It has been observed that the environmental temperature in and around Bangalore is been in increasing significantly over several years.

2. Materials and Methods

2.1 Experimental Design: Twelve lactating dairy cows with similar body weight and production levels were selected and divided into three treatment groups of four animals each. The details of treatments groups designated as T_1 (Without any cooling facility), T_2 (animals under this group were sprinkled with water through micro sprinklers once in 2 hours during day time) and T_3 (Wet gunny bags were used as cooling effect). The experimental animals were housed in the standard managemental practices and fed according to ICAR (2013).

2.2 Environmental variables: The daily minimum and maximum temperature and relative humidity inside the experimental shed was recorded by using digital hygro thermometer. Whereas, outside the experimental shed data collected from Meteorological Department located near by the study area at GKVK, UAS, Bangalore.

2.3 Biochemical parameters: Serum Cortisol and electrolytes *viz.*, serum sodium (Na) and serum potassium (K) levels were estimated on 0th day, 30th day and 60th day of the experiment. Blood samples from each animal of the three treatment groups were collected between 06:00am & 07:00am. The site of blood collection was sanitized using isopropyl alcohol before collection of blood. Blood samples (5 ml) were collected from the jugular vein of the experimental animals into a clean, dry, sterilized test tube prior to the morning feeding. Serum samples were analyzed for cortisol levels with the help of MiniVIDAS equipment (CORS kit). The estimation of serum cortisol levels was carried out based on ELFA (ENZYME LINKED FLUORESCENT ASSAY) as per the standard operating procedure prescribed by manufacturer. The electrolytes - Sodium (Na) and Potassium (K) were measured using semi-automatic chemistry analyzer from Trivitron labmate equipment. These estimations were based on colorimetric principle as per the standard operating procedure prescribed by manufacturer.

3. Results and Discussion

3.1 Environmental variable

The average minimum and maximum ambient temperature recorded inside the shed during the study period (summer months) was 18.7 and 31.5 °C respectively. Whereas, the minimum and maximum relative humidity recorded inside the shed during entire study period (summer months) was 36.4 and 79.2 per cent respectively and the average minimum and maximum ambient temperature recorded outside the shed during the study period (summer months) was 20.2 and 32.1 °C respectively. Whereas, the minimum and maximum relative humidity recorded outside the shed during entire study period (summer months) was 41.7 and 84.0 per cent respectively and are presented in Table 1.

The temperature and humidity recorded during the experiment were higher compared to the upper limit of the comfort zone values as reported other researchers [10]. However, the upper limit recorded during the experiment has negligible effect on the biochemical parameters of the animals [8]. The adaptation /usage of the cooling mechanisms used in the study might be a beneficial effect to combat heat stress in dairy animals, especially in very hot climatic conditions. The results obtained in the present study were in line with previous studies [7, 5]. Where in the ambient temperature and relative humidity was much above the upper limit of comfort zone values as well as the values recorded for the same during the entire trial period.

Table 1: Average mean values of ambient temperature and relative humidity inside and outside the experimental shed during summer months.

	Inside the experimental shed				Outside the experimental shed			
Months	**AT (°C)**		**R H (%)**		**AT (°C)**		**R H (%)**	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
April	18.3	32.5	33.1	80 .7	19.6	33.3	38.1	85.3
May	19.2	30.8	38.2	78.0	20.6	31.5	43.0	83.0
June	18.7	31.2	38.0	79.0	20.4	31.7	44.0	83.7
Avg. values	18.7	31.5	36.4	79.2	20.2	32.1	41.7	84.0

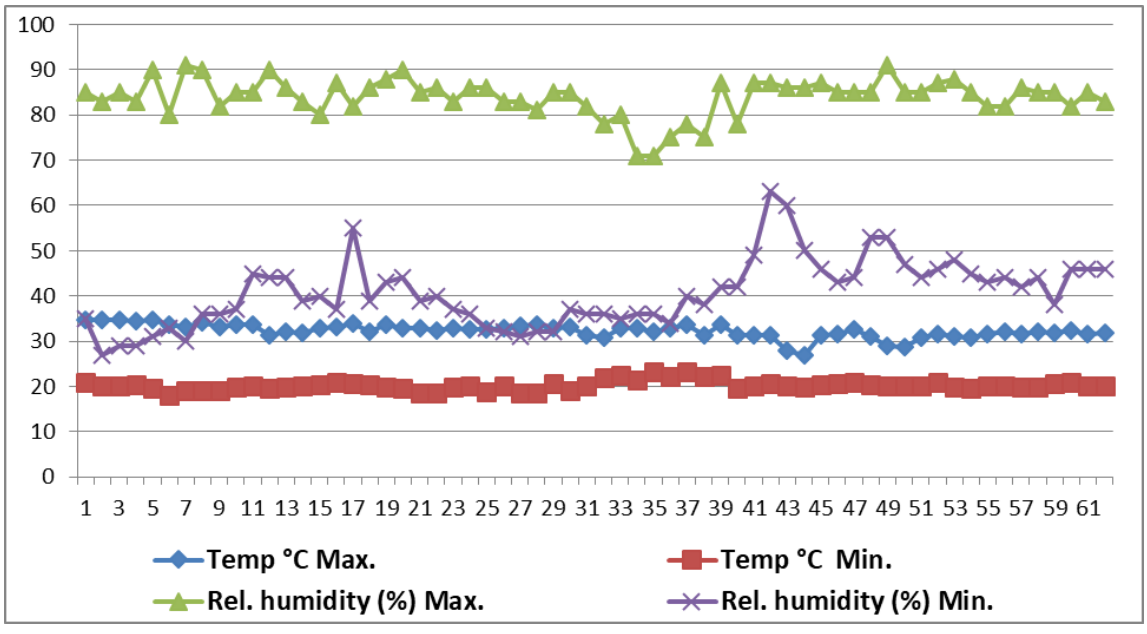

Fig 1: Daily variation of minimum and maximum ambient temperature and relative humidity outside the experimental animal shed.

3.2 Biochemical Parameters

3.2.1 Serum cortisol (µg/dl)

The average values for serum cortisol levels (ug/dl) in animals maintained under control group (T_1) estimated on 0th, 30th and 60th day was 0.83±0.33, 1.05±0.16 and 0.89±0.13. The similar values for T_2 (animals maintained with micro-sprinklers as cooling method) was 0.94±0.34, 0.71±0.1 and 0.61±0.10. Whereas, serum cortisol levels for animals maintained under treatment group T_3 (animals with wet gunny bags as cooling mechanism) recorded on 0th, 30th and 60th day was 1.17±0.25, 0.84±0.22 and 0.94±0.30 respectively. The overall mean values of serum cortisol levels of the experimental animals during study period for the group T_1 T_2 and T_3 were 0.92±0.07, 0.75±0.10 and 0.98±0.10 respectively and are presented in Table 2 and graphically presented in Figure 2. The statistical analysis revealed that there was a non-significant difference among all the treatment groups for serum cortisol levels. Whereas lowest cortisol level was observed in animals maintained under micro sprinkler (T_2) compared to animals maintained under control (T_1) and gunny bags (T_3). There was non-significant difference was found among the treatment groups. 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 HPA and sympatho-adrenal medullary axis. Similarly, the results from current study line with other reports [9, 11]. The non-significant results obtained in the current experiment might be due to lower range of ambient temperature in the current study area as compared to report of other workers.

3.2.2 Serum sodium (mEq/L)

The overall mean values of serum sodium (mEq/L) levels of the experimental animals during trial period for T_1, T_2 and T_3 were 144.27±0.03, 145.55±0.42and 145.15±0.06 respectively. Similarly, serum potassium (mEq/L) levels of the experimental animals during trial period for T_1, T_2 and T_3 was 4.22±0.10, 4.15±0.06 and 4.34±0.08 respectively, and are presented in Table 2 and depicted graphically in Figure 3. The statistical analysis revealed that there was non-significant difference in serum sodium and serum potassium levels among all the treatment groups. When animals were exposed to above the upper limit of comfort zone may increase the quantities of ion lost by urine and skin evaporation. The decreased the sodium and potassium were related to increase in the loss of urinary sodium and loss of skin potassium due to heat stress revealed researchers [4, 9, 12]. The non-significant results obtained in the current experiment might be due to lower range of ambient temperature in the current study area as compared to report of other workers.

3.2.3 Serum potassium (mEq/L)

The mean±SE values for serum potassium level (mEq/L) estimated on 0th, 30th and 60th day for all treatment groups is presented in Table 2 and depicted in Figure 4. The mean±SE values of serum potassium level (mEq/L) for T1 on 0th, 30th and 60th day was 4.05±0.06, 4.23±0.08 and 4.38±0.13. The similar value for T2 was 4.05±0.10, 4.15±0.13 and 4.25±0.06. These values for T3 were 4.20±0.12, 4.33±0.09 and 4.48±0.06, respectively. The overall mean±SE values of serum potassium (mEq/L) level of the experimental animals during trial period for T1, T2 and T3 was 4.22±0.10, 4.15±0.06 and 4.34±0.08, respectively. The statistical analysis revealed that there was non-significant difference in serum potassium level among all the treatment groups. The levels of potassium differed non-significantly among the three treatment groups. When animals were exposed to above the upper limit of comfort zone may increase the quantities of ion lost by urine and skin evaporation. The decrease in potassium levels were related to increase in the loss of urinary sodium and loss of skin potassium due to heat stress reported by other workers [4, 9, 12]. The non-significant results obtained in the current experiment might be due to lower range of ambient temperature in the current study area as compared to reports of other workers.

Table 3: Mean values of serum cortisol, sodium and serum potassium (mEq/L) levels estimated on 0th, 30th and 60th day for all treatment groups

Days of estimation	Serum cortisol (ug/dl) hormone levels			Serum sodium (mEq/L) levels			Serum potassium (mEq/L) levels		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
0	0.83±0.33	0.94±0.34	1.17±0.25	144.25±1.72	146.13±1.06	145.05±0.72	4.05±0.06	4.05±0.10	4.20±0.12
30	1.05±0.16	0.71±0.11	0.84±0.22	144.33±0.49	145.80±0.87	145.25±0.37	4.23±0.08	4.15±0.13	4.33±0.09
60	0.89±0.13	0.61±0.10	0.94±0.30	144.23±0.72	144.73±0.47	145.15±0.31	4.38±0.13	4.25±0.06	4.48±0.06
Mean ± SE	0.92±0.07	0.75±0.10	0.98±0.10	144.27±0.03	145.55±0.42	145.15±0.06	4.22±0.10	4.15±0.06	4.34±0.08

Note: Statistically Non-significant difference observed between all the treatments in all the parameters

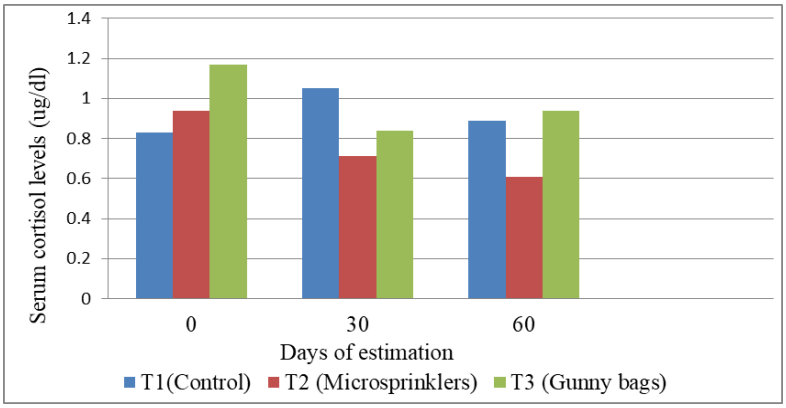

Fig 2: Serum cortisol (µg/dl) hormone level estimated on 0th, 30th and 60th day for three treatment groups.

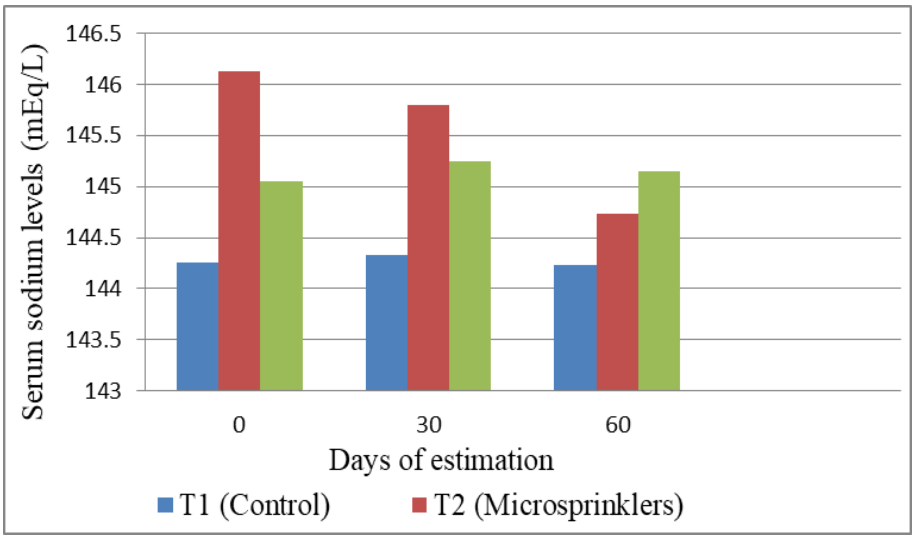

Fig 3: Serum sodium level (mEq/L) estimated on 0th, 30th and 60th day for treatment groups.

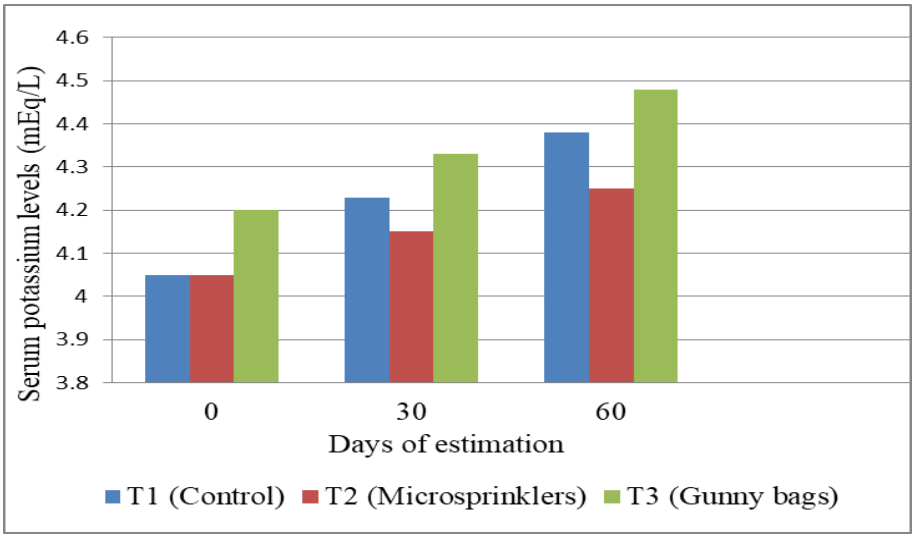

Fig 4: Serum potassium level (mEq/L) estimated on 0th, 30th and 60th day for treatment groups.

4. Conclusion: The prevailing climatic condition in the study area showed non-significant effect on all the biochemical parameters, indicating that the environment the study area is more conducive for livestock farming activities. However, the studies involving large number of animals for a longer period of time is needed to ascertain the results obtained in the current experiment.

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