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Influence of temperature variability on physiological and haematological changes in indigenous Kangayam cows

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Abstract
The study is conducted to explore the Physiological and haematological changes in adult lactating Kangayam cows during summer (April- June) and winter (December- February) season on its native tract of Tamil Nadu. A total of 10 Kangayam cows with age between 3 to 5th lactation was selected for this study. Physiological responses like respiratory rate, pulse rate, rectal temperature, skin temperature and sweating rate were measured during both seasons. The temperature humidity index also calculated during both season to know the effect of environmental stress on animals. The blood samples were collected during both seasons and haematological parameters like red blood cells, haemoglobin, packed cell volume, total white blood cells, different leukocytes and platelets were studied to compare the seasonal effect and physiological adaptation to harsh environmental conditions. The results revealed that all physiological variables except rectal temperature were significantly (p<0.05) increased during summer than winter season. In haematological parameters the red blood cells (RBCs), Hemoglobin (Hb) were significantly (p<0.05) reduced during summer than winter season. There is no difference in packed cell volume (PCV), Mean corpuscular Volume (MCV), Mean corpuscular haemoglobin (MCH), Mean corpuscular haemoglobin concentration (MCHC) and different white blood cells in both seasons. Whereas white blood cells and platelets were significantly (p<0.05) increased during winter than summer. All changes in haematological variables within reference range only. This study indicated that the changes in physiological and haematological response acted as one of the adaptation process of the animal to withstand the adverse environmental conditions and to maintain body homeostasis.

Keywords: Kangayam cow, physiological and haematological parameter and season

Introduction
The livestock sector contributes a vital role in the country's economy with a share of 3.9 per cent in total GDP. India is the largest milk producer in the world and producing over 187.75 million tones (BAHS 2019) [3]. As per 19th Livestock census, India possesses 192.49 million cattle population, in which the population of exotic or crossbred animals is 50.42 millions and that of indigenous and nondescript animals is 142.11 millions. The indigenous female cattle population was increased by 26.9% in 2019 as compared to Livestock census 2012 (BAHS 2019) [3]. Animals which belong to descript (identified) and nondescript (non- identified) breeds of indigenous origin are considered as indigenous animals. The number of registered native cattle breeds in India is 43 (Savalia *et al.*, 2019) [16].
It is also noted that Tamil Nadu state possess five indigenous breeds namely, Kangayam, Bargur, Pulikulam, Alambadi and Umbalachery, Among these indigenous breeds, Kangayam breed of cattle is considered as one of the best-known superior draught breed in Tamil Nadu and it is known for its superior qualities such as adaptation to poor nutrition and longevity (Kandasamy, 2001) [10].
In recent years, the environmental temperature increases gradually due to global warming and animals are susceptible to various types of stress such as physical, chemical, nutritional and physiological and thermal stress. Exposure of cows to hot environment stimulates thermoregulatory mechanisms and produces reduction in the rates of metabolism, feed intake and productivity (Abdelatif and Alameen, 2012) [1].
Animals experience heat stress due to imbalances in heat intake and loss, which alters their bodies function physiologically. Body immunological functions are lowered when the metabolism is altered. The changes in environmental variables temperature, humidity and rainfall greatly affect the growth, production and reproduction of the animals. The equilibrium between heat uptake and heat loss systems determines the body temperature of animals.

Heat load change the homeostasis of the body and make the animal physiologically harmful (Gaughan *et al*., 2012) [8]. Temperature humidity index is used as indicator of the thermal climatic conditions and of stress degree on cows Kadzere *et al*. (2002) [9].

The haematological parameters are influenced by many factors like breed, age, sex, seasonal variation, lactation, pregnancy, health and nutritional status of the animal. Seasonal and environmental changes may influence haematological values in domestic animals (Feldman *et al*., 2002) [6]. The perusal of literature reveals that studies on physiological and haematological changes during different environmental conditions pertaining to Kangayam breed of cattle are scanty. The study related to assessment of physiological and haematological changes during heat stress used as a marker and revel the heat tolerance ability of the Kangayam cows.

Materials and Methods

The study is to explore the physiological and haematological parameters and heat tolerance ability of indigenous Kangayam (*Bos indicus*) cow during different environmental conditions (summer and winter). Temperature and relative humidity were recorded before measurement of physiological parameters and collection of blood for haematological studies by calculate the temperature-humidity index and assess the stress level of the experimental animals under different climatic conditions.

Animal selection

10 adult Kangayam cows with 3–5 years of age were selected for this study. The experiments were carried out during two distinct phases coinciding with two seasons of the year, *viz*., winter (December–February 2019) and summer (April–June 2019). At the time of the experiment, all the animals were clinically healthy and free from any abnormalities. All these animals were maintained under the same management conditions.

Physiological parameters

The thermo-physiological parameters of skin temperature (ST, °C), rectal temperature (RT, °C), ambient temperature, respiratory rate (RR, breaths/min), and pulse rate (PR, beats/min), were recorded from individual cows during blood collection.

The skin temperature was recorded at neck, body and flank region using non-contact infrared thermometer by placing the thermometer 4-6 cm away from the skin surface directing towards the vicinity site, where temperature was proposed to be measured and the average of these 3 values was recorded. The rectal temperature was measured by digital thermometer inserted into rectum. The movement of flank of each animal was monitored for one min to record the respiratory rate in animals. After evaluation of respiratory rate pulse rate was recorded in coccygeal artery. Before taking these physiological parameters, the animals were ensured to be in relaxed state.

Temperature Humidity Index Calculation

Temperature and relative humidity Index (THI) were recorded before blood collection to assess the effect of environment on animal physiological and haematological profile and level of stress. THI was estimated using air temperature and relative humidity to assess the risk of heat stress in Kangayam during both seasons. Air temperature and relative humidity were measured using portable digital psychrometer (HHAQ-106, OMEGA) before recording of physiological parameters and blood collection.

THI was calculated by the formula,

$$THI = 0.8*T + RH*(T-14.4) + 46.4$$

Where T = ambient or dry-bulb or air temperature in °C and RH=relative humidity expressed as a proportion i.e., 70% humidity is expressed as 0.70.

Sample collection

About 5 ml of fresh blood samples were drawn six times at two-week intervals aseptically from the jugular vein of each animal and transferred into potassium ethylenediamine tetraacetic acid (K3 EDTA)-coated tubes (BD-Plymouth PL6 7BP, UK) during the winter (December–February 2019) and summer (April–June 2019) seasons. The collected samples were immediately transported to a laboratory under refrigeration conditions and processed same day. At the time of the experiment, all the animals were clinically healthy and free from any abnormalities.

The blood samples were subjected to evaluate the haematological profiles using an automated blood cell analyser (VetScan, with software). A portion of blood was directly used to estimate the red blood cell (RBC), Haemoglobin (Hb), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) and total leukocyte count (TLC) and platelets count (PLT) during summer and winter season.

The percentage distribution of differential leucocytes was determined after smearing the peripheral blood and staining with Leishman's stain. The cells were counted manually and expressed in percentage. All haematological examinations were performed within 24 h sampling to avoid error due to cell lysis.

Statistical analysis

The data collected were analyzed using one- way ANOVA and independent t test in SPSS Version 21.0 software package. Results are presented as means with a standard error of mean.

Results and Discussion

The study of physiological and haemato-biochemical parameters would be helpful in understanding of certain metabolic disorders and diseases under field conditions. The physiological responses to environment like heart rate (HR), rectal temperature (RT), pulse rate (PR) and respiration rate (RR) reflect the degree of stress imposed on animals by climatic factors (Ganaie *et al*., 2013) [7]. The haematological values will provide valuable baseline information and help in realistic evaluation of management practices, nutritional and physiological status of animals and health conditions.

Physiological parameters

The effect of season /THI on Physiological parameters during summer and winter were presented in Table 1. The rectal temperature during summer and winter is constant without any change whereas other parameters like respiratory rate, pulse rate, skin temperature vary between two seasons. The temperature and relative humidity was 96 during summer and

86 during winter season.

The increased respiratory rate and pulse rate in present study during summer (THI =96) than winter (THI=86) season is one of the compensatory mechanism of the body to maintain homeostasis. The observations of physiological changes due to summer stress concurs with findings of Kim *et al*. (2023) [11] who reported that increased physiological parameters in beef cows exposed to severe heat stress conditions to maintain body homeostasis. These fluctuations during experimental periods can be attributed to change in water balance. High environmental temperatures may lead to higher evaporative water loss through the skin surface, as well as the respiratory tract, thereby requiring compensatory water intake to regulate body temperature. (Moustafa *et al*., 1977; Ogebe *et al*., 1996) [12, 14].

Similarly, Priyanka Pande *et al*. (2017) [15] reported fluctuations in physiological values in Tharparkar and Karan Fries heifers can be used as an index for assessing the adaptation capacity of cattle to changing climate that helps in the acclimatization process of animals during stressful period and can be used to assess the impact of thermal and CO2 stress in ruminants. Similarly in present study, elevations of physiological response of Kangayam cows during summer is an adaptation response to summer stress to maintain homeostasis.

Our results are agreement with findings of Chandra bhan *et al*. (2013) [5] who also reported increased respiratory rate in Karan Fries cows during summer over spring season. The same kind of responses were identified in dairy cows by Sindhu Berian *et al*. (2020) [4] mentioned that variations in physiological response shows it's adapt and cope with different environmental conditions. A current results of study agreement with researcher like Silpa Mullakkalparambil Velayudhan *et al*. (2022) [18] identified a significant effect of seasonal transition on respiration rate (RR) in lactating dairy cattle.

Haematological parameters

The changes in haematological parameters are given in Table2. The number of RBCs, Haemoglobin were significantly (p<0.05) increased during summer than winter season. Other parameters like packed cell volume, MCV, MCH, MCHC and platelets slightly reduced during summer and normal during winter. The values of WBCs and platelets were increased during winter than summer. There is no change in different leukocytes numbers between two seasons.

The findings of Vaibhav Purwar *et al*. (2019) [17] the RBC and Hb values were corroborate with present study during both seasons. Regarding WBCs and platelet count the results of Silpa Mullakkalparambil Velayudhan *et al*. (2022) [18] also reported similar to present study observation in crossbred lactating cow in tropical savanna climate. Whereas, contrary to our study the other haematological parameters are not affected by THI.

Abdelatif *et al*. (2009) [1] reported higher erythrocytes count during wet summer compared to winter and dry summer. Likely, Chandra bhan *et al*. (2013) [5] who reported that an average of WBC in cattle (growing and adult) was higher during winter compared to summer relates our present study values. The Hb and WBCs values of present study concurs with findings of Nikita Bhalakiya *et al* (2021) [13]. Whereas the platelet and total erythrocyte values were contrary to present study in lactating Kankrej cow.

The increased numbers of RBCs and Hb level during summer may be due to haemoconcentration of the blood to maintain homeostasis of the body by evaporative heat loss and sweating during summer. The increased WBCs and platelet may be due to fight against invading microorganism to protect the body while exposed to infection during winter season.

Contrary to present study the RBCs and Hb levels increased during summer than winter season in high altitude cold desert crossbred Jersey cattle. Further the Wbc number also increased during summer than winter season (Arup Giri *et al*., 2017) [2].

Table 1: Mean (±SE) thermo-physiological parameters in Kangayam cattle during summer and winter

Breed	Season	Respiratory rate/min	Pulse rate/min	T^{rectal} (°C)	$T^{dorsal\ coat}$ (°C)	T^{air} (°C)	RH (%)	Temperature and humidity index (THI)
Kangayam	Summer	32.26 ^{b}±1.32	66.34.46 ^{b}±1.33	39.2±0.1	37.9±0.1	40	70	96.32 ^{b}±4.5
	Winter	20.42 ^{a}±1.32	64.27 ^{a}±1.51	38.9±0.2	37.1±0.2	32	80	86.08 ^{a}±3.1

Each value is mean of ten observations.

Means with different superscripts in a same row differ significantly (p<0.05)

Table 2: Mean (±SE) Total erythrocyte count, haemoglobin, packed cell volume and erythrocyte indices of Kangayam calves during different climatic conditions

Parameters/ Season	RBC ($X10^6$/µl)	Hb (g %)	PCV (%)	MCV (pg)	MCH (fl)	MCHC (%)	WBC ($X\ 10^3$/µl)	Neutrophils (%)	Eosinophils (%)	Basophils (%)	Lympho cyte (%)	Monocyte (%)	Platelets ($x10^3$/µl)
Summer	9.55^{b}±0.50	9.26±0.20	25.49±1.0	37.50±1.5	10.12±0.9	32.00±0.9	8.52^{a}±0.80	42.30±2.40	1.20±0.40	0.10±0.30	65.00±2.70	6.30±0.40	192.0^{a}±14.00
Winter	8.65^{a}±0.50	8.65±0.68	27.35±0.10	39.46±0.40	11.67±0.8	33.62±0.20	13.48^{b}±0.84	34.10±1.40	1.30±0.40	0.10±0.30	60.00±1.30	5.30±0.40	263.0^{b}±14.00

Each value is mean of ten observations.

Means with different superscripts in a same row differ significantly (p<0.05)

Conclusion

The increase in physiological response during summer shows adaptability of indigenous Kangayam cows during harsh environmental conditions. The changes in haematological variables with in reference range due to seasonal effect of environment that in turn alters feed and water intake of the animals. The RBC and Hb values increased during summer than winter season whereas WBCs and platelet values were increased during winter than summer. The research would be as baseline data for further study of molecular response of indigenous Kangayam cows.

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