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Season influences the key physiological and haematological traits in Sahiwal cows

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Abstract
This study was an effort to find out if season influences the key physiological and haematological parameters in Sahiwal indicine cows. The physiological data of 50 Sahiwal cows, and haematology of 15 Sahiwal cows per season was evaluated, so that a total of 400 physiological observations and 60 haematological observations across four seasons spanning one year was made. The prevailing microclimatic variables (temperature and relative humidity) were recorded to derive the Temperature Humidity Index (THI). The effect of seasons was evaluated using the correlation. Statistical analysis revealed the physiological parameters to be positively correlated with the THI, whereas most of the haematological parameters were negatively correlated with the THI.

Keywords: Physiology, sahiwal cows, haematology, seasonal influence

Introduction
Environmental stressors, particularly heat stress imposes a significant burden on dairy cows in tropical countries like India. Heat stress has been associated with a number of negative effects on animals, from reduced feed intake to reduced reproductive performance. The mechanism of heat stress is still a subject of research, with new insights being reported frequently. Across season analysis helps develop a better understanding of the effects of thermal stress on physiology and associated adaptation/acclimatization in animals. THI is a commonly utilized indicator of assessing heat stress levels and its impact on the productivity of dairy cattle [1, 2]. An environment is usually considered stressful for dairy animal when the THI exceeds 72. THI in excess of 70s has been found to adversely affect the physiology of animals, manifested in altered physiological responses, haematological and biochemical changes, perturbations in behaviour and reducing the reproductive efficiency of animals [3, 4, 5]. With this study, an effort was made to understand the correlation between THI and key physiological and haematological parameters of Sahiwal cows, if any exists either positive or negative. This will help in predicting animal responses and devise appropriate stress amelioration strategies.

Materials and Methods
The present study was carried out over a period of one year in the cattle yard of in Sahiwal cows reared in Livestock Research Station, Bikaner. The prevailing microclimatic variables were measured for three consecutive day per season using a digital hygrometer. The temperature and relative humidity were used to calculate THI using the formula: $THI = (1.8 \times Tdb + 32) - (0.55 - 0.0055 \times RH) \times (1.8 \times Tdb - 26)$ [7]. The physiological data (Rectal temperature, Respiration Rate, Pulse rate and Body surface temperature at ventral, dorsal, lateral and frontal points) was recorded for 50 cows per season twice daily: early morning (8:00-10:00 AM) and afternoon (1:30-3:30 PM), across all four seasons. Rectal temperature (RT) of each animal was recorded using a digital thermometer. The thermometer was kept in contact with the rectal mucosa for 2 minutes and observations were recorded. The RT values were expressed in °F. Respiration rate (RR) of each animal was recorded from visual observation of the thoracic-abdominal area and counting the breathing movements during one minute (breaths/min). Pulse rate (PR) of each animal was recorded by feeling the pulsation in the middle of coccygeal artery at the base of the tail. The PR values were expressed in beats per minute. Body surface temperature (BST) was recorded using non-contact thermal infrared gun. Skin temperature was taken at the dorsal, lateral, ventral and frontal regions of the animal, and the ST values were expressed in °F.

For haematological parameters, blood samples (2 ml/animal) were collected in EDTA coated vacutainer tubes from 15 animals per season. Blood samples were used for quantification of various haematological parameters in automated hematology analyzer (Mindray BC 3600 auto hematology analyzer) was used to estimate red blood cells (RBC) count, hemoglobin (Hb), packed cell volume (PCV), platelets, white blood cell (WBCs) count, differential leucocyte count (DLC) and percent (neutrophil, lymphocytes, monocytes, eosinophil, and basophils), Mean corpuscular volume (MCV), and mean corpuscular hemoglobin.

The data generated on Physiological parameters and haematology were correlated with the THI data using Pearson's coefficient of correlation (p<0.01) in SPSS 25.0, to find if the THI influenced these parameters significantly or not.

Results and Discussion

The correlation between physiological parameters and THI is presented in table 1. The physiological parameters showed a positive correlation with the THI, with the coefficient of correlation being 0.493, 0.614, and 0.783 between RT, RR, and PR. While the BST at all points revealed a very high magnitude of correlation with the prevailing THI, with coefficient of correlation being 0.846, 0.806, 0.820, and 0.869 between dorsal, lateral, ventral, and frontal BST and THI. The correlation between physiological parameters and THI is presented in table 2. Among the key haematological parameters, the erythrocytic parameters haemoglobin level, PCV, and RBC counts were found to be negatively correlated with THI, and the magnitude of correlation was -0.494, -0.471, and -0.469 for haemoglobin, PCV, and RBC counts, respectively. Furthermore, the WBC counts, platelets count, and lymphocytes count were also negatively correlated to THI, with the magnitude of correlation being -0.545, -0.756, and -0.398 for WBC counts, platelets count, and lymphocyte counts, respectively. However, the neutrophil counts were positively correlated to THI with the coefficient of correlation being 0.273.

The data collected during the course of our study pertaining to meteorological parameters indicated that the THI of summer and hot-humid months were leaning towards stressful periods. Similar to our findings, earlier works of Bhan *et al*. (2013) also revealed the Indian summer and hot-humid seasons are coupled with extended periods of high THI, which is associated with numerous physiological, haematological, biochemical and associated changes in animals.

Table 1: Correlation of physiological parameters with THI

	THI	RT	PR	RR	Dorsal BST	Lateral BST	Ventral BST	Frontal BST
THI	1	.493**	.783**	.614**	.846**	.806**	.820**	.869**
RT		1	.375**	.249**	.422**	.392**	.409**	.403**
PR			1	.586**	.743**	.733**	.775**	.758**
RR				1	.677**	.705**	.705**	.712**
Dorsal BST					1	.820**	.860**	.866**
Lateral BST						1	.889**	.926**
Ventral BST							1	.885**
Frontal BST								1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2: Correlation of haematological parameters with THI

	THI	Haemoglobin	PCV	RBC	WBC	Platelets	Neutrophils	Lymphocytes
THI	1	-.494**	-.471**	-.469**	-.545**	-.756**	.273**	-.398**
Haemoglobin		1	.966**	.500**	.291**	.432**	-.101	.182
PCV			1	.481**	.296**	.425**	-.127	.162
RBC				1	.028	.433**	.126	.181
WBC					1	.302**	-.268**	.195
Platelets						1	-.161	.317**
Neutrophils							1	-.142
Lymphocytes								1

**. Correlation is significant at the 0.01 level (2-tailed).

Physiological parameters are the most overt expressions of animals when presented with stressors. The physiological parameters showed a positive correlation with the THI, same observations were reported by earlier researchers [7, 8, 9] who found higher values of physiological parameters during periods of high THI. Moreover, Koubkova *et al*. (2002) [10] and Sakatani *et al*. (2012) [11] reported a seasonal rhythm in RR, with higher values coinciding with period of higher THI. As the atmosphere heats up gradually from morning till afternoon and maximum temperature conditions for a day coincides with the afternoon periods, the noon is associated with higher values of physiological parameters. Furthermore, an increased respiration is one of the first visible signs of heat stressed animal [12]. There have been variable reports on effect of thermal stress in animals, however, there's a consensus that most haematological parameters are negatively correlated with the THI [13, 14]. Thermal stress is known to modulate most of the haematological parameters, via the central nervous system (CNS), haematological changes occur in livestock subjected to thermal stress and seasonality [14, 15]. These studies corroborate our results that THI influences the key haematological parameters of Sahiwal cows.

In different studies conducted in past, there was a strong consensus that indicine breeds have better tolerance to higher THI, while taurine cattle have higher physiological stress even at relatively lower THI [16]. Various studies covering different season has established that *Bos indicus* breeds have better thermotolerance as compared to their taurine counterparts [17, 18]. In many countries, the superior thermotolerance capability of *Bos indicus* have been exploited in various crossbreeding programs to develop breed which are both high producing as well as thermotolerant.

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