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Seasonal stress disrupts physiological and haematological variables in cattle

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ABSTRACT

Health and productivity of dairy cattle can be severely affected by seasonal stress, particularly in regions experiencing extreme winter and hot conditions. The aim of present study is to determine seasonal stress disrupt physiological and haematological variables in both indigenous and exotic breed of cattle. The THI were observed in spring (M-65.96, AN-75.84), summer (M-78.04, AN-88.96), humid (M-76.92, AN-85.88) and winter (M-53.49, AN-74.86). The results showed that seasonal changes were significant concerning of physiological variables such as RT, PR and RR. Moreover, the results showed that seasonal changes were significant concerning of haemomogram and leucogram indices like haemoglobin, RBC count, PCV, MCH, MCHC, MCV, WBC, neutrophils, lymphocyte, eosinophils, monocytes and platelet. Seasonal changes influence blood components, often due to changes in hemoconcentration and metabolic demand. Local cattle consistently showing greater stability and thermotolerance than crossbreds cattle. The various physiological variables and haematological were established to be ideal indicators for quantifying heat stress in several farm animals. Therefore, these physiological variables such as RT, PR, RR, hematological can be effectively used to assess the severity of heat stress in livestock.

Key Words - Cattle, seasonal stress, haematological indices, leukogram, diseases.

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INTRODUCTION

The development of the animal husbandry sector has great significance for the overall growth of Bihar's economy. The region of Bihar is divided into two distinct sub-geographical regions, north and south of the Ganges River. Bihar is thus predominantly depended on an agricultural and there is also a large scope for improving animal husbandry. Animal husbandry in is one of the most important key sectors which plays an important role in income opportunities and employment for the rural population of Bihar. However, the effects of increasing temperatures on livestock will be different in worldwide, basically it is based on latitude and farming systems. Global warming and climate change is expected to a major concern during recent years, and the livestock sector will be one of the most affected segments of the agricultural industry. Increasing atmospheric temperature and humidity during summer months are a thermal threat not only for human as well as species like farm animals, and welfare (Das *et al.,* 2016).

In the tropical countries such as India, the livestock population is subjected to extremes of temperatures and in the course of time has developed various physiological, behavioral and genetic adaptations to cope up with stressful environment. Stress is a response of the body when subjected to disturbance in the normal homeostasis, often associated with detrimental effects. When animals are exposed to an extreme hot or cold environment, they experience discomfort and physiological strain (Wu *et al.,* 2025). The evaluation of the physiological variables is very important as a reference for the maintenance and development of different livestock. This study was conducted to investigate changes in the physiological variables of indigenous cow as well as exotic cows, determine critical threshold values, and identify the physiological variables that show higher reliability for the assessment of heat stress in dairy cows. The physiological variables such as RT, PR, RR, hematological profile is one of the most important parameters for the assessment of heat stress in cattle. These variables can provide crucial information for the monitoring welfare of livestock, which can very helpful for increasing livestock production and productivity.

High rectal temperature (RT), altered water and dry matter intake, reduced metabolic rate and efficiency of feed utilization are an impotent physiologic response that are associated with negative impacts of heat stress on production and reproduction in cattle (McManus *et al.,* 2020). Continuous exposure to intense heat stress influences thermoregulatory mechanisms, leading to a marked increase in respiratory rate, followed by an increase in rectal temperature. Associated responses includes a decrease in dry matter intake, induction of metabolic shifts, redistribution of blood flow, and decrease in heat rate as part of the physiological adaptations (Ferrazza *et al.,* 2017). Thermal stress refers to condition of heat stress during extreme summer season as well as cold stress during extreme winter season. The animals have variable physiological, cellular and biochemical responses when subjected to thermal stress. The heat stress response is a highly conserved cascade of protein activation and altered gene expression in response to a variety of stressors (Sonna *et al.,* 2002; Collier *et al.,* 2006). The physiological parameters like rectal temperature, skin temperature, pulse rate and respiration rate increased significantly in sahiwal cattle with an increase in ambient temperature and relative humidity Chandrabhan *et al.,* (2012). Scharf *et al.,* (2010) reported an increase in rectal temperature and respiration rate in Bos taurus cattle in response to heat stress. Despite the well-known differences in their response to heat stress, there is still little information regarding the critical level of these traits for local cows. The physiological variables along with hematological indices may quick and reliable data in order to know the stress state of animals.

MATERIALS & METHODS

Temperature and humidity were recorded made on daily basis during the observing physiological data and blood sampling. Various physiological parameters like respiration rate (RR), rectal temperature (RT), pulse rate (PR), were recorded in a total of 100 each of local cattle and cross breed across different seasons (hot summer/humid, winter and spring) in morning (7.00-9.00 AM) as well as in afternoon time point (1.00- 3.00 PM). Rectal temperature in each animal were recorded using digital thermometer by keeping the thermometer in contact for 2 min within the rectal mucosa. Pulse rate of each animal were counted by feeling the pulsation of the middle coccygeal artery at the base of the tail and respiration rate of each animal were recorded from visual observation of the inward and outward movement of the flank while the ST including dorsal, lateral, ventral and frontal region was recorded using the infrared thermal gun.

The haematological parameters including red blood cell count (RBCs), hemoglobin (Hb), packed cell volume (PCV), Mean corpuscles volume (MCV), mean corpuscular hemoglobin concentration (MCHC), and mean corpuscular hemoglobin (MCH),

white blood cells count (WBCs), platelets, neutrophil, lymphocytes, monocytes, eosinophil count as well percentage, were evaluated in a total of 40 animals (10 animals/breed/season) using an automatic hematology analyzer.

Statistical analysis

Raw data were analyzed by using IBM statics software SPSS through compare mean (One way ANOVA) for descriptive analysis with post hoc test.

RESULTS

Physiological changes

The data regarding seasonal changes in physiological parameters in local and cross breed cattle are presented in Table 1. The results showed that seasonal changes were significant concerning of RT, PR and RR. The rectal temperature of local cattle in morning time point, of summer season was significantly higher ($p<0.05$) whereas, in afternoon time point significantly higher ($p<0.05$) in both summer and humid season as compared to spring season. The rectal temperature of cross breed cattle significantly higher ($p<0.05$) in morning time point of summer and humid season and in afternoon time point significantly higher ($p<0.05$) only in humid season when it was compared to spring season. However, significantly lower ($p<0.05$) in morning and afternoon time point of winter season. The pulse rate of local cattle in morning and afternoon time point of summer and humid season were significantly higher ($p<0.05$) whereas, significantly lower ($p<0.05$) in winter season as compared to spring season. The pulse rate of cross breed cattle in morning and afternoon time point of summer and humid season were significantly higher ($p<0.05$) whereas, significantly lower ($p<0.05$) in winter season as compared to spring season. The respiration rate of local cattle significantly higher ($p<0.05$) in morning time point of summer and humid season and significantly lower ($p<0.05$) in winter season whereas, in afternoon time point significantly higher ($p<0.05$) only in humid and significantly lower ($p<0.05$) in winter season as compared to spring. The respiration rate of cross breed cattle significantly higher ($p<0.05$) in morning time point of summer and humid season and significantly lower ($p<0.05$) in winter season whereas, in afternoon time point significantly higher ($p<0.05$) only in humid and significantly lower ($p<0.05$) in winter season as compared to spring.

Haematological changes

The data regarding seasonal changes in haemogram indices in local and cross breed cattle are presented in Table 2. The results showed that seasonal changes were significant level is ($p<0.05$) concerning of haemoglobin, RBC count, PCV, MCH, MCHC, and MCV. The haemoglobin was significantly lower in humid season of local cattle whereas, in

Table 1: Change in physiological parameters in different time point of different season

Parameters	Breed	Time point	Spring, THI (M-65.96, AN-75.84)	Summer, THI (M-78.04, AN-88.96)	Humid, THI (M-76.92, AN-85.88)	Winter, THI (M-53.49, AN-74.86)
Rectal Temperature (^{0}F)	Local cattle	M	100.57±0.03	100.69±0.05	100.90*±0.04	100.51±0.03
		AN	101.32±0.04	101.53*±0.05	101.79*±0.04	101.39±0.05
	Cross breed	M	100.79±0.04	101.06*±0.06	101.22*±0.03	100.43*±0.06
		AN	101.62±0.04	101.74±0.04	101.79*±0.03	101.09*±0.05
Pulse Rate (Pulse/min.)	Local cattle	M	53.36±0.19	58.78*±0.32	56.52*±0.19	55.12*±0.22
		AN	56.92±0.24	62.22*±0.13	64.09*±0.20	61.76*±0.43
	Cross breed	M	54.86±0.31	58.72*±0.36	59.90*±0.25	57.78*±0.29
		AN	56.60±0.53	64.44*±0.25	63.82*±0.16	61.03*±0.24
Respiration Rate (Breath/min.)	Local cattle	M	24.70±0.15	25.66*±0.17	27.09*±0.17	23.87*±0.09
		AN	27.78±0.08	28.03±0.28	31.50*±0.26	26.91*±0.18
	Cross breed	M	25.41±0.20	26.88*±0.15	27.49*±0.09	24.02*±0.19
		AN	26.78±0.21	31.08±0.12	31.36*±0.09	26.26*±0.17

Values are expressed as mean ± SE. *Indicate significantly difference as compared to spring

cross breed cattle, significantly lower in both summer and humid season as compared to spring. The RBCs were significantly lower in summer and humid season of both local cattle and cross breed cattle. The PCV were significantly lower in summer and humid season of local cattle. The MCH were significantly lower in humid season of local cattle whereas significantly lower in both summer and humid season in cross breed cattle. The MCHC were significantly lower humid and higher in winter season of local cattle whereas, in cross breed cattle significantly lower in both summer and humid season. The MCV were significantly higher in summer season of cross breed cattle as compared to spring. The data regarding seasonal changes in leucogram indices in local and cross breed cattle are presented in Table 3. The results showed that seasonal changes were significant concerning of WBC, neutrophils, lymphocyte, eosinophils, monocytes and platelet.

Table 2: Change in haemogram parameters in different time point of different season

Parameters	Breed	Spring	Summer	Humid	Winter
WBC (count/cmm)	LC	9690.00±209.47	10731.40±595.60	11060.00±659.16	10066.00±195.16
	CB	7830.00±288.31	8341.30±206.37	11700.0*±854.53	7788.20±169.13
Neutrophils (%)	LC	31.50±1.11	32.40±0.58	33.70±0.65	32.20±1.29
	CB	36.90±0.50	38.20±0.71	39.60±1.09	37.40±0.67
Lymphocyte (%)	LC	60.80±1.74	59.10±1.31	55.40±1.19	49.60*±3.14
	CB	53.60±1.00	51.00±0.67	49.40*±1.54	52.10±1.15
Eosinophils (%)	LC	5.00±0.33	5.70±0.33	6.40*±0.22	5.60±0.37
	CB	4.40±0.34	5.90±0.41	6.10±0.86	6.90*±0.31
Monocytes (%)	LC	3.90±0.41	3.60±0.50	3.10±0.23	3.60±0.31
	CB	5.50±0.17	5.10±0.28	4.20*±0.20	5.00±0.37
Neutrophils (cells/µL)	LC	2475.90±63.65	2681.90±72.06	2836.40±102.06	3234.30*±166.19
	CB	3468.10±60.51	3625.70±44.90	3833.60*±58.90	3426.20±79.40
Lymphocyte (cells/µL)	LC	5863.20±38.73	5773.60±86.11	5569.80*±53.45	5474.0*±87.19
	CB	3960.00±51.64	3569.40*±77.01	3518.10*±91.01	3788.60±45.00
Eosinophils (cells/µL)	LC	465.80±28.98	460.80±82.87	712.40*±26.55	573.30±58.47
	CB	414.60±31.34	424.00±47.73	677.10*±94.92	495.90±27.59
Monocyte (cells/µL)	LC	447.60±9.53	344.30*±11.21	333.60*±8.38	359.0*±11.02
	CB	356.00±9.89	305.70±12.21	304.20±10.58	355.40±59.78
Platelet (lakhs/ µL)	LC	2.83±0.21	2.62±0.23	2.03*±0.26	1.94*±0.11
	CB	2.91±0.21	2.33±0.14	2.47±0.20	2.98±0.21

Values are expressed as mean ± SE. *Indicate significantly difference as compared to spring

Table 3: Change in leucogram parameters in different time point of different season

Parameters	Breed	Spring	Summer	Humid	Winter
Haemoglobin (gm/dl)	LC	11.22±0.35	10.09±0.33	9.07*±0.16	11.35±0.39
	CB	9.93±0.17	8.16*±0.11	7.67*±0.14	9.39±0.21
RBC count (million/cmm)	LC	7.07±0.14	6.30*±0.15	6.16*±0.13	6.53±0.21
	CB	6.11±0.12	5.28*±0.10	5.18*±0.10	5.98±0.21
PCV (%)	LC	31.04±0.29	27.60*±0.45	25.89*±0.71	29.32±0.87
	CB	27.25±0.39	25.90±0.34	25.64±0.58	24.28±0.41
MCH (pictogram)	LC	15.60±0.17	14.81±0.54	13.77*±0.29	16.82±0.23
	CB	16.62±0.14	15.20*±0.15	14.81*±0.34	17.14±0.13
MCHC (gm/dl)	LC	34.41±0.44	33.49±0.31	31.07*±0.44	36.77*±0.36
	CB	35.33±0.45	31.73*±0.23	31.82*±0.46	35.64±1.25
MCV (fl)	LC	44.30±0.48	44.68±0.53	44.38±0.95	44.31±0.51
	CB	45.14±0.31	47.96*±0.51	43.32±1.17	43.16±0.44

Values are expressed as mean ± SE. *Indicate significantly difference as compared to spring

WBCs of cross breed cattle were significantly higher in humid seasons. The lymphocyte was significantly lower of local cattle in winter season whereas significantly lower in humid season of cross breed cattle. The eosinophil was significantly higher in humid season of local cattle whereas significantly higher in winter season of cross breed cattle. The monocyte was significantly lower in humid season of cross breed cattle. The platelet was significantly lower in humid and winter season of cross breed cattle.

DISCUSSION

The physiological response viz., pulse rate, respiration rate and rectal temperature significantly increased in summer and humid season. These change in physiological responses agreement with the study of Prasanna *et al.,* (2022) in cross breed cattle (Sailo *et al*., 2015b; Verma *et al.,* 2015; Das, 2016) and stated that higher rectal temperature in summer season of both exotic as well as indigenous cattle. The temperatures increases may be attributed to excessive heat production due to high metabolic rate. The basal metabolic rate of indigenous cattle is generally lower compared to exotic which may be one reason for maintaining a homeostasis when exposed to higher ambient temperature and exhibiting heat tolerance (Dalcin *et al.,* 2016).

The respiration rate of local cattle and cross breed cattle significantly higher summer and humid season and significantly lower in winter season agreement with the study of Singh *et al.,* 2018 in cross breed cattle and (Sailo *et al.,* 2015a; Verma *et al.,* 2015; Das, 2016). The increase in respiration rate in summer and humid season as compared to spring seasons may be due to an adaptive response of the animal to maintain homoeothermic balance through the more demand of oxygen by the tissues in stressful conditions. The changes in the respiration rate are an adaptive response of the animal to cope with the homoeothermic balance. In domestic animals, RR increases due to the activation of thermo-receptors in the skin when they are exposed to higher ambient temperature. Such activation of the receptors, in turn, sends neural signals to the hypothalamus that increases respiratory activity to accelerate heat loss from the body by respiratory evaporation (Haidary, 2004).

The pulse rate of local cattle and cross breed cattle significantly higher in summer and humid season whereas, significantly lower in winter season as compared to spring season agreement with the study of (Singh *et al.,* 2018) in cross breed cattle and (Chetia *et al.,* 2016; Sailo *et al.,* 2017). The increase in PR causes an increase in the blood flow to the surface and thereby facilitates heat loss (Marai *et al.,* 2007). Therefore, significantly higher physiological responses observed in the present experiment during the summer season might be due to the high ambient temperature and the relative humidity which in turn increased THI and exceeded comfort zone of the animals, resulting in the imbalance in the heat energy produced and dissipated. In order to adjust the environmental temperature, all the physiological parameters might have been increased.

The haemoglobin was significantly lower in humid season of local cattle whereas, in cross breed cattle, significantly lower in both summer and humid season as compared to spring. This finding agreement with the study of Chandra Bhan *et al.,* (2012). The RBCs were significantly lower in summer and humid season of both local cattle and cross breed cattle as compared to spring season agreement with the study of Mirzadeh *et al.,* (2010); Chandra Bhan *et al.,* (2012). The PCV were significantly lower in summer and humid season of local cattle. This finding agreement with the study of Abdelatif and Alameen, (2012) could be attributed to hemodilution and decrease cellular oxygen demand to minimize metabolic heat production (Rameshwar *et al.,* 2023). The MCH and MCHC were significantly lower in summer and humid season in both breed agreement with the study of (Rameshwar *et al.,* 2023). The MCV were significantly higher in summer season of cross breed cattle as compared to spring agreement with the study of Gaafar *et al.,* (2021). WBCs of cross breed cattle were significantly higher in humid season agreement with the study of Lateef *et al.* (2014).

CONCLUSION

The indigenous breeds were exhibiting less physiological variability as compared to cross breed across season. The various physiological variables and haematological were established to be ideal indicators for quantifying heat stress in several farm animals. Therefore, these physiological variables such as RT, PR, RR, hematological can be effectively used to assess the severity of heat stress in livestock.

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