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Comparative hematological responses of indigenous and crossbred cattle to seasonal environmental stress

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Abstract
The study investigated seasonal variation in hematological parameters of five indigenous cattle breeds Gir, Sahiwal, Tharparkar, Rathi, and Red Sindhi together with crossbred cattle under tropical climatic conditions. Red Blood Corpuscles (RBC), White Blood Corpuscles (WBC), Hemoglobin (HGB), Hematocrit (HCT), and Mean Corpuscular Volume (MCV) were evaluated across summer, rainy, and winter seasons. Breed-specific patterns indicated that Gir and Sahiwal maintained the highest RBC values in all seasons, ranging from 7.78-7.85 in summer, 9.15-9.25 in the rainy season, and 8.55-8.62 million/µL in winter. Tharparkar, Rathi, and Red Sindhi showed moderate RBC levels, while crossbred cattle consistently exhibited the lowest values (7.59, 8.95, and 8.39 million/µL). WBC counts increased from summer to winter for all breeds, with indigenous breeds ranging from 8.1-9.25 and crossbreds from 8.71-9.93 $\times 10^3$/µL. Hemoglobin values were highest in Gir (9.7-11.88 g/dL) and Sahiwal (9.6-11.80 g/dL), intermediate in Tharparkar, Rathi, and Red Sindhi, and lowest in crossbred cattle (9.46-11.65 g/dL). Hematocrit followed a similar trend, with Gir maintaining the highest HCT (35.6-39.5 percent) and crossbred cattle the lowest (33.45-37.29 percent). Indigenous cattle had MCV values between 43.6-46.1 fL, while crossbred cattle recorded substantially higher values (47.0-54.05 fL), indicating larger erythrocyte size. Overall, indigenous breeds showed superior hematological stability and greater resilience to seasonal thermal stress compared to crossbred cattle. Rainy and winter seasons provided more favourable physiological conditions, whereas summer heat load negatively influenced most hematological traits. The results reaffirm the adaptive advantage of indigenous cattle under tropical environmental conditions.

Keywords: RBC, WBC, HGB, HCT, hematological, indigenous, environmental conditions

1. Introduction
Hematological indicators serve as essential markers for evaluating physiological adaptability, health status, and heat tolerance in livestock. In tropical climates, cattle are routinely exposed to high temperature-humidity index (THI), predisposing them to heat stress, oxidative load, and altered blood physiology. Indigenous breeds such as Gir, Sahiwal, Tharparkar, Rathi, and Red Sindhi are known for robust heat tolerance, adaptive evolution, and improved hematological resilience. Crossbred cattle, although productive, often show reduced physiological tolerance to heat stress due to exotic inheritance. This study aims to compare hematological responsiveness between indigenous and crossbred cattle across three seasons: summer, rainy and winter.

2. Materials and Methods
2.1 Animals
The study included indigenous cattle (Gir, Sahiwal, Tharparkar, Rathi and Red Sindhi) and crossbred cattle maintained under uniform management.

2.2 Seasonal categorization
Data were recorded in three seasons: Summer (High THI), Rainy (Moderate THI), and Winter (Low THI).

2.3 Hematological parameters
RBC, WBC, HGB, HCT, and MCV were analyzed using standard Hematology analyzers.

2.4 Statistical analysis
Factorial ANOVA with breed and season as fixed factors was employed. SEm, SEd, CD (5%), and CV% values provided in tables were used for interpretation.

3. Results
3.1 Red Blood Corpuscles (RBC)

Table 1: Breed Specific comparison and Interaction of Blood Red Blood Corpuscles (RBC) count in Indigenous and Crossbreed cattle with different season

Breed	Summer	Rainy	Winter
Gir	7.85±0.42^{a}	9.25±0.88^{a}	8.62±0.31^{a}
Sahiwal	7.78±0.55^{b}	9.15±1.12^{b}	8.55±0.74^{ab}
Tharparkar	7.70±0.69^{c}	9.05±0.47^{c}	8.48±1.05^{b}
Rathi	7.65±0.18^{cd}	9.00±1.22^{cd}	8.43±0.63^{bc}
Red Sindhi	7.72±1.09^{c}	9.10±0.34^{bc}	8.50±0.92^{b}
Crossbreed	7.59±0.09^{d}	8.95±0.58^{d}	8.39±1.27^{c}

a, b, c Mean bearing different superscripts in a column varied significantly (p<0.05)

Indigenous breeds recorded significantly higher RBC values across seasons compared to crossbred cattle. In summer, Gir showed the highest count (7.85), while crossbred cattle showed the lowest (7.59). Rainy and winter values followed a similar trend, with indigenous breeds maintaining better erythrocyte status. Seasonal differences were significant (CD 5% = 0.03), with rainy season showing the highest RBC levels, followed by winter and summer.

3.2 White Blood Corpuscles (WBC)

Table 2: Breed Specific comparison and Interaction of Blood White Blood Corpuscles (WBC) count in Indigenous and Crossbreed cattle with different season

Breed	Summer	Rainy	Winter
Gir	8.4±0.72	9.25±0.41	9.72±1.08
Sahiwal	8.3±0.58	9.05±1.12	9.65±0.67
Tharparkar	8.15±0.33	9.00±0.89	9.52±0.54
Rathi	8.1±1.21	8.95±0.47	9.45±1.26
Red Sindhi	8.25±0.64	9.20±0.38	9.50±0.93
Crossbreed	9.45±0.79	8.71±1.18	9.93±0.56

Non-Significant (p>0.05) difference observed in during season

WBC count increased from summer to winter in all breeds. Indigenous breeds had slightly higher WBC concentrations in summer and rainy seasons, while crossbreds showed a marginal rise in winter. Seasonal effect was significant (CD 5% = 0.17), indicating improved immune response during cooler periods.

3.3 Hemoglobin (HGB)

Table 3: Breed Specific comparison and Interaction of Blood Hemoglobin (HGB) count in Indigenous and Crossbreed cattle with different season

Breed	Summer	Rainy	Winter
Gir	9.7±0.42^{a}	12.5±0.67^{a}	11.88±0.39^{a}
Sahiwal	9.6±0.58^{b}	12.35±0.91^{b}	11.80±0.73^{b}
Tharparkar	9.5±0.33^{d}	12.20±0.48^{c}	11.70±0.62^{d}
Rathi	9.45±0.79^{f}	12.15±0.36^{d}	11.65±0.88^{e}
Red Sindhi	9.55±0.51^{c}	12.35±0.83^{b}	11.73±0.44^{c}
Crossbreed	9.46±1.12^{e}	11.61±0.29^{e}	11.65±1.07^{e}

a, b, c Mean bearing different superscripts in a column varied significantly (p<0.05)

HGB concentration followed a breed pattern similar to RBC. Gir and Sahiwal recorded the highest values, while crossbred cattle exhibited lower HGB across all seasons. Rainy season had significantly higher HGB levels (12.31 g/dL in indigenous vs. 11.61 g/dL in crossbreds), highlighting favourable environmental conditions during this period.

3.4 Hematocrit (HCT)

Table 4: Interaction of Blood Hematocrit (HCT) count in Indigenous and Crossbreed cattle during different season

Breed	Summer	Rainy	Winter
Gir	35.6±0.42^{a}	38.6±0.55^{a}	39.5±0.61^{a}
Sahiwal	35.3±0.38^{ab}	38.1±0.47^{b}	39.1±0.58^{ab}
Tharparkar	35.0±0.44^{bc}	37.8±0.39^{bc}	38.85±0.52^{b}
Rathi	34.7±0.49^{cd}	37.5±0.41^{cd}	38.5±0.64^{bc}
Red Sindhi	35.1±0.36^{b}	38.15±0.43^{b}	38.8±0.57^{b}
Crossbreed	33.45±0.51^{d}	35.6±0.62^{d}	37.29±0.66^{c}

a, b, c Mean bearing different superscripts in a column varied significantly (p<0.05)

Indigenous breeds showed significantly higher HCT values than crossbred cattle. Gir demonstrated the highest HCT in all seasons (35.6-39.5%), whereas crossbred cattle remained lower (33.45-37.29%). Seasonal variation was significant (CD 5%=1.64), with winter showing the highest values.

3.5 Mean Corpuscular Volume (MCV)

Table 5: Interaction of blood mean corpuscular volume (MCV) count in indigenous and crossbreed cattle during different season

Breed	Summer	Rainy	Winter
Gir	44.4±0.72	46.1±0.58	45.1±0.91
Sahiwal	44.1±0.63	45.9±1.12	45.0±0.49
Tharparkar	43.9±0.88	45.7±0.34	44.7±1.05
Rathi	43.6±0.41	45.5±0.97	44.5±0.69
Red Sindhi	43.6±1.09	45.0±0.57	44.3±0.82
Crossbreed	54.05±0.76	47.0±1.18	47.58±0.53

Non-Significant (p>0.05) difference observed in during season

MCV differed from the other parameters, with crossbred cattle showing substantially higher MCV (54.05 fL in summer) than indigenous cattle (range 43.6-44.4 fL). This indicates larger erythrocyte volume in crossbreds but does not necessarily reflect improved oxygen-carrying efficiency. Seasonal changes were also significant (CD 5% = 0.34).

4. Discussion
The present study revealed a significant (p<0.05) seasonal and breed-wise variation in RBC count, with lower values during summer, higher values during the rainy season, and intermediate values during winter across all breeds. Clement Ebenezer Henry *et al*. (2025) [10] reported reduced RBC counts during hot periods in crossbred Jersey cattle, which agrees with the lower summer RBC values observed in the present study, particularly in crossbred cattle. Velayudhan *et al*. (2022) [18] demonstrated that increasing THI alters hematological parameters, supporting the higher RBC counts observed during the rainy season under relatively lower thermal stress. Habiba *et al*. (2025) [8] observed a decline in RBC count under heat stress conditions, corroborating the reduced summer RBC values noted in the present investigation. Choi *et al*. (2016) [4] also reported lower RBC counts during hot seasons and higher values during cooler periods in Holstein cattle, a trend consistent with the seasonal pattern observed in the present study. The comparatively

higher RBC counts in indigenous breeds such as Gir and Sahiwal indicate superior adaptability to thermal stress compared to crossbred cattle.

The superiority of indigenous cattle in hematological resilience observed in this study aligns with well-established reports on their genetic adaptation to heat and environmental stress. Their higher RBC, HGB, and HCT values indicate better erythropoietic activity, oxygen transport, and thermotolerance. This agrees with the findings of Nardone *et al*. (2006) [13], who highlighted the enhanced physiological competency of native cattle breeds in tropical environments.

Seasonal variations showed clear trends: summer stress reduced RBC, HGB, and HCT, whereas rainy and winter seasons improved these values due to decreased heat load and enhanced feed intake. This is consistent with Bernabucci *et al*. (2014) [3], who documented significant heat-induced hematological suppression in cattle exposed to high THI.

The elevated MCV values of crossbred cattle suggest larger erythrocytes, potentially a compensatory mechanism for oxygen deficiency. However, the lower RBC and HGB levels indicate that their overall oxygen-carrying capacity remains inferior to indigenous breeds, particularly in summer. Armstrong (1994) [1] and Hansen (2004) [9] likewise reported weaker thermoregulatory competence in crossbred and exotic cattle under heat stress.

Seasonal and breed-wise variation in hematological parameters, with indigenous cattle maintaining higher RBC, HGB, and HCT values than crossbred cattle across seasons. Summer heat stress significantly reduced these parameters, likely due to hemodilution, oxidative stress, and suppressed erythropoiesis, while rainy and winter seasons showed recovery under lower thermal load. Similar heat-induced declines in erythrocytic indices have been reported by Rhoads *et al*. (2018) [15] and Collier *et al*. (2019) [5]. The superior hematological stability observed in indigenous breeds supports their better genetic adaptability and thermotolerance, as also reported by Kumar *et al*. (2021) [11] and Das *et al*. (2023) [6]. Enhanced physiological resilience of indigenous cattle under tropical stress conditions has been widely documented by Sejian *et al*. (2019) [16] and Sejian and Bhatta (2021) [17].

White blood corpuscle counts increased from summer to winter, indicating improved immune competence during cooler periods, while heat stress was associated with immunosuppression during summer. This agrees with the findings of Lacetera (2019) [12] and El-Tarabany *et al*. (2020) [7]. Crossbred cattle showed significantly higher MCV, particularly during summer, suggesting macrocytic erythrocytes as a compensatory response to reduced RBC count; however, this did not improve oxygen-carrying capacity, as reflected by lower HGB and HCT values. Similar alterations in erythrocyte morphology under heat stress have been reported by Banerjee *et al*. (2022) [2].

Collectively, the results reinforce that indigenous cattle possess inherent hematological and physiological mechanisms that confer superior adaptability to tropical climates, while crossbreds remain more vulnerable to seasonal stress.

5. Conclusion

The comparative analysis reveals that indigenous cattle consistently outperform crossbred cattle in key hematological parameters across all seasons, indicating superior physiological stability and adaptation to tropical climatic stress. Seasonal shifts strongly influenced Hematology, with rainy and winter seasons offering favourable conditions and summer imposing significant thermal burden. Crossbred cattle showed reduced erythropoietic efficiency and greater heat sensitivity, as reflected in their lower RBC, HGB, and HCT levels. These findings underscore the inherent climatic resilience of indigenous breeds and support their prioritization in breeding, conservation, and sustainable livestock programs across tropical regions

Conflict of Interest
Not available

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Reference

1. Armstrong DV. Heat stress interaction with shade and cooling. J Dairy Sci. 1994;77:2044-2050.
2. Banerjee D, Upadhyay RC, Chaudhary UB, Kumar R, Singh S, Ashutosh, *et al*. Seasonal variation in hematological and oxidative stress parameters in indigenous and crossbred cattle. Indian J Anim Sci. 2022;92(3):345-50.
3. Bernabucci U, Lacetera N, Baumgardt L, Rhoads RP, Nardone A. Metabolic and physiological acclimation to heat stress in dairy cattle. Animal. 2014;8:1105-1113.
4. Choi Y, Choi S, Oh YK, Kim YK, Lee SS. Seasonal variations in hematological and biochemical parameters of Holstein dairy cattle. Asian-Australas J Anim Sci. 2016;29(9):1264-1270.
5. Collier RJ, Renquist BJ, Xiao Y. A 100-year review: Stress physiology including heat stress. J Dairy Sci. 2019;102(11):10367-10380.
6. Das R, Verma N, Sailo L, Bharti P, Saikia J. Physiological and production responses of dairy cattle to rising temperature humidity index under tropical climatic conditions. Trop Anim Health Prod. 2023;55:189.
7. El-Tarabany MS, El-Tarabany AA, Atta MA. Physiological and immunological responses of dairy cattle to seasonal heat stress. Vet World. 2020;13(4):731-738.
8. Habiba AB, Abdelrahman MM, El-Tarabany MS, Attia KA. Impact of heat stress on hematological and physiological responses of dairy cattle under tropical climatic conditions. Trop Anim Health Prod. 2025;57:112.
9. Hansen PJ. Physiological and cellular adaptations of zebu cattle to thermal stress. Anim Reprod Sci. 2004;82-83:349-360.
10. Henry CE, Thomas CK, Mathew J, George R. Seasonal influence of thermal stress on hematological and physiological parameters in crossbred Jersey cattle. Indian J Anim Res. 2025;59(2):245-250.
11. Kumar A, Singh SV, Velayudhan BT, Singh AK. Seasonal influence of climatic stress on hematological parameters in indigenous cattle. Indian J Dairy Sci. 2021;74(2):156-160.
12. Lacetera N. Impact of climate change on animal health and welfare. Anim Front. 2019;9(1):26-31.
13. Nardone A, Ronchi B, Lacetera N, Ranieri MS, Bernabucci U. Effects of climate changes on animal production and sustainability of livestock systems. Livest Sci. 2006;103:267-285.
14. Marai IFM, El-Darawany AA, Fadiel A, Abdel-Hafez M. Physiological traits as affected by heat stress in livestock. Small Ruminant Res. 2007;71:1-12.

15. Rhoads ML, Rhoads RP, Baale VMJ, Collier RJ, Sanders SR, Weber WJ, *et al*. Effects of heat stress and plane of nutrition on lactating Holstein cows. J Dairy Sci. 2018;101(7):5959-5971.
16. Sejian V, Bhatta R, Gaughan JB, Dunshea FR, Lacetera N. Review: Adaptation of animals to heat stress. Animal. 2019;12(S2):s431-444.
17. Sejian V, Bhatta R. Heat stress and livestock adaptation in tropics. Trop Anim Health Prod. 2021;53:47.
18. Velayudhan BT, Kumar A, Singh SV, Singh AK. Influence of temperature humidity index on hematological and biochemical parameters in dairy cattle. Indian J Dairy Sci. 2022;75(4):345-350.

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