RESEARCH ARTICLE
Open Access

Journal of Veterinary and Animal Sciences
ISSN (Print): 0971-0701, (Online): 2582-0605
https://doi.org/10.51966/jvas.2021.52.3.222-227

Association of temperature humidity index during summer with haematological parameters in native and crossbred goats of Kerala*

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Citation: Debia, Y., Beena, V., Ramnath, V., Venkatachalapathy, T. R. and Zarina, A. 2021. Association of temperature humidity index during summer with haematological parameters in native and crossbred goats of Kerala. *J. Vet. Anim. Sci.* **52**(3): 222-227
DOI: https://doi.org/10.51966/jvas.2021.52.3.222-227

Received: 14.01.2021 *Accepted: 08.03.2021* *Published: 30.09.2021*

Abstract

The study was conducted to investigate the association of temperature humidity index (THI) during summer with haematological responses in Malabari, crossbred and Attappady goats of Kerala. The research work was conducted at University Goat and Sheep Farm, KVASU, Mannuthy, Thrissur district in Kerala from March to May, 2020. In-house temperature and in-house relative humidity were measured daily at 7.00 AM, 10.00 AM, 2.00 PM and 5.00 PM. Haematological parameters such as total erythrocyte count (TEC), total leucocyte count (TLC), haemoglobin concentration (Hb), volume of packed red cells (VPRC), mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) were analysed during 2nd, 32nd day and 60th day of the study. There was no significant change in TEC, VPRC levels in between the breeds and within the observed days. However, TLC were significantly increased for Malabari goats and MCHC were significantly increased in all the breeds at 32nd day of study period. The Hb concentration were significantly increased in crossbred and Attappady black at 32nd day of study period. There was a significant decrease in MCV values in 2nd and 32nd day for all the breeds. The study demonstrated certain altered hematological features in all the breeds under study indicating the adaptive ability of these animals during heat stress.

Keywords: *Goats, thermal stress, Temperature Humidity Index, haematological parameters*

**Part of MVSc thesis submitted to Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, Kerala*

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India's average temperature has increased by 0.7°C during 1901–2018. According to Intergovernmental Panel of Climate Change (IPCC) 2018, global warming is likely to reach 1.5°C in between 2030 and 2052; 1.5°C increase in global surface temperature will have devastating consequences on both human and animal population. The climate change has lately turned to be one of the most serious and long-standing term of considerable challenges experienced by livestock owners and farmers. In these circumstances, goat rearing has been identified as a sustainable livestock rearing system and has gained economic importance in almost all countries facing harsh climatic events frequently. Goats has the ability to cope with climate change by expressing adaptive strategies as compared to other ruminants (Silanikove, 2000) because of their lower body mass, lower metabolic requirements, ability to reduce metabolism, skillful grazing behavior and effective urea cycling (Silanikove and Koluman, 2015). The main climatic variables that impose impact on goats are high ambient temperature, high direct and indirect solar radiation, wind speed and humidity (Silanikove, 2000). Temperature humidity index (THI), a reliable indicator of stressful thermal environment could be used for measuring the heat load in animals. Goats are known for their tolerance to heat stress but they suffer from thermal stress beyond their comfort zone and environmental temperatures for goats fall in the range between 13-27°C (Mishra, 2009). Goat subjected to heat, would experience a transition from being ideal in its internal state and thus experience a degree of stress.

There are several phenotypic and genotypic adaptive abilities that provide goats to counter thermal stress. Identification of these adaptive capabilities in various goat breeds of Kerala would help to select the most appropriate goat breed for the future and also to identify the various management strategies to be adopted for sustainable goat farming.

Assessment of haematological parameters gives an evaluation of the health status of the animals. During periods of thermal stress there will be alteration in physiological features for maintenance of homeostasis. Assessing the severity of these alterations would give an idea about the adaptive capacity of these animals to a great extent and would also help to identify the most climate resilient goat breed suitable for hot, humid tropical climate of Kerala. Hence, this study was undertaken to assess the association of THI with haematological parameters in Malabari, crossbred and Attappady goats of Kerala.

Materials and methods

The research work was conducted at University Goat and Sheep Farm, Kerala Veterinary and Animal Sciences University (KVASU), Mannuthy, Thrissur district in Kerala state. Farm is located at 10° 56" N and 76° 26" E at an altitude of 2.83m. The period of study was 60 days from March 2020 to May 2020 during which high thermal stress was experienced. Six animals each from Attappady black, Malabari and crossbred (Malabari X Saanen) female goats of eight to 12 months of age were selected and divided into three groups. All animals were apparently healthy and free from any physical abnormalities. Animals were housed in the elevated platform with corrugated roof sheet and were fed as per Indian Council of Agricultural Research (ICAR) feeding standards and provided with *ad lib.* water (ICAR, 2013).

Ambient temperature (°C) and ambient relative humidity (%) inside the shed were recorded by electronic digital logger (HOBO pro V2, Onset Computer Corporation, USA) on every alternate day of study period at 7.00 A.M, 10.00 A.M, 2.00 P.M and 5.00 P.M. Temperature Humidity Index was calculated as per livestock and poultry heat stress indices **(**LPHSI, 1990**)**

$$THI = T_{(db)} - \{(0.55-0.55RH)\ (T_{(db)} - 58)\}$$

Where,

$T_{(db)}$ = Dry bulb temperature (°F)

RH = Relative humidity (%)

Blood samples were collected into vacutainers through venipuncture on days 2, 32 and 60 between 11.00 AM to 12 noon. Whole blood was collected in vacutainer containing 3.6 mg potassium ethylene diamine tetra acetic acid salt (EDTA) for immediate haematological

analyses. Haematological parameters like total erythrocyte count (TEC), haemoglobin (Hb), volume of packed red blood cells (VPRC) and total leucocyte count (TLC) were estimated in whole blood using haematological analyser (Mythic 18 vet-blood analyser). The erythrocyte indices such as mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) were calculated as described by Schalm *et al.* (1986).

Statistical analysis

Results were expressed as means (±SE). The data obtained on various parameters were statistically analysed as per the method of Snedecor and Cochran (1994) using analysis of variance (ANOVA), repeated measures of ANOVA and Pearson's correlation method. The whole data were analysed using computerized software programme SPSS V. 24.0.

Results and discussion

In-house ambient temperature (IT)

The mean in-house temperatures were highest in the month of March (39.54°C) and the lowest during month of April (23.91°C). Harikumar (2017) recorded the maximum interior temperature during March (39.86°C) in Kerala. The in-house temperature recorded by Zarina (2016) in Thrissur was maximum during 2nd half of March (36.03°C). Jisha *et al.* (2021) also found that highest mean of average temperature over a period from 2011-2016 was in March in Thrissur, Kerala.

The diurnal in-house temperature when observed during the different times, the lowest was observed at 7.00 AM (24.61°C) and the highest was at 2.00 PM (37.54°C). Harikumar (2017), could observe highest between 2.00-3.00 PM in Thrissur and Jisha *et al.* (2021) found highest in-house temperature in the afternoon (around 3.00 PM) during the period of March to May at Mannuthy, Thrissur, Kerala.

In-house relative humidity (IRH)

The highest monthly mean in-house relative humidity was noticed in the month of May (98.69%) and lowest in the month of March (37.83%). Similar results were also recorded by Zarina (2016) and Harikumar (2017), where the interior relative humidity was maximum in May and lowest in April (when compared for a period from March – May) and explained that the higher humidity in May was due to summer rain. The relatively lesser summer rain received and higher ambient temperature in the month of March, 2020 might be the reason for the lowest relative humidity observed in this study during the month.

The mean diurnal in-house relative humidity (recorded at four times) was the highest at the time of 7.00 AM (98.69%) and the lowest at 2.00 PM (37.83%). The lowest value recorded at 2.00 PM might be due to the highest ambient temperature at 2.00 PM.

Temperature Humidity Index (THI) (LPHSI, 1990)

Highest THI of 88.63 was recorded in April while the lowest THI of 74.45 was noticed in March. This study was in accordance with Jisha *et al.* (2021), where the highest mean THI was recorded in April (81.74) during the period from 2011-2016 in Thrissur. The maximum THI in April (86.70) was also noted by Harikumar (2017) in Thrissur.

In the present study highest mean THI of 89.65 was observed at 2.00 PM and lowest THI of 75.69 at 7.00 AM. This study was in accordance with Jisha *et al.* (2021) who found lowest THI in the morning and highest in afternoon during the period of March to May at Mannuthy, Thrissur, Kerala.

Total Erythrocyte Count (TEC)

In the present study, the IT and THI had no effect in TEC values of breeds during the entire study period and the TEC values were within normal range. This study was similar with Hassan *et al*. (2013), Bhatta *et al*. (2014). In the latter study they found no changes in TEC levels in Beetal goats during post monsoon (34.6°C) and pre monsoon (42.6°C). Whereas, Alam *et al*. (2011), Okoruwa (2014) and Habibu *et al.* (2017) found increase in TEC levels in goats when ambient temperature and THI were high.

Total Leucocyte Count (TLC)

The total leucocyte count showed an increasing trend for Malabari goats during the study. However, no significant difference in TLC levels were observed for crossbred goats and Attappady black goats breeds. The result of the present study was in agreement with Alam *et al*. (2011), Banerjee *et al*. (2015), Olayemi *et*

Table 1. Inside the animal house during March 2020 to May 2020

Period	In-house temperature (°C)			In-house relative humidity (%)			In-house THI		
	Mean ± SE	Lowest	Highest	Mean ± SE	Lowest	Highest	Mean ± SE	Lowest	Highest
March	30.88 ± 0.08	24.29	**39.54**	67.39 ± 3.34	**37.83**	92.40	82.64 ± 0.82	**74.45**	87.34
April	30.76 ± 0.12	**23.91**	37.51	70.97 ± 1.51	52.97	97.84	83.71 ± 0.46	75.69	**88.63**
May	29.56 ± 0.14	24.56	36.01	78.15 ± 1.61	58.19	**98.69**	82.94 ± 0.40	76.40	87.81

Table 2. Inside the animal house during different times from March 2020 to May 2020

Time	In-house temperature (°C)			In-house relative humidity (%)			In-house THI		
	Mean ± SE	Lowest	Highest	Mean ± SE	Lowest	Highest	Mean ± SE	Lowest	Highest
7.00 AM	27.45 ± 0.21	**24.61**	29.43	89.94 ± 1.15	74.16	**98.69**	80.08 ± 0.31	**75.69**	83.28
10.00 AM	32.18 ± 0.26	28.15	34.51	73.30 ± 1.32	57.17	95.68	85.16 ± 0.31	81.53	87.88
2.00 PM	34.99 ± 0.36	28.30	**37.54**	63.10 ± 1.58	**37.83**	84.74	87.33 ± 0.34	80.84	**89.65**
5.00 PM	33.56 ± 0.27	28.69	35.88	67.57 ± 1.39	44.54	83.74	86.18 ± 0.27	81.35	88.59

Table 3. Mean ± SE of TEC, TLC and Hb of Malabari, crossbred and Attappady black goats

Day of study	THI	TEC (X 10^6/µL)			TLC(X 10^3/µL)			Hb (g/dL)		
		Malabari	Crossbred	Attappady black	Malabari	Crossbred	Attappady black	Malabari	Crossbred	Attappady black
2nd day	82.64	11.87 ± 0.66	11.82 ± 0.88	12.16 ± 0.36	9.87^{aA} ± 0.65	13.58^{abA} ± 2.07	14.78^{bA} ± 1.60	7.87^{A} ± 0.33	7.72^{A} ± 0.12	8.03^{A} ± 0.23
32nd day	83.71	10.56 ± 0.80	11.55 ± 0.58	11.06 ± 0.96	11.73^{aB} ± 0.82	13.12^{aA} ± 1.27	13.77^{aA} ± 1.33	9.37^{A} ± 0.42	9.83^{B} ± 0.53	9.27^{B} ± 0.54
60th day	82.94	11.06 ± 0.85	11.45 ± 0.42	12.02 ± 0.86	13.97^{aB} ± 0.94	14.58^{aA} ± 0.71	11.28^{aA} ± 0.67	8.83^{A} ± 0.90	8.06^{A} ± 0.21	7.17^{A} ± 0.24

Means bearing same superscript within a row (a-c) and columns (A-C) do not differ significantly ($p<0.05$) (n=6)

Table 4. Mean ± SE of VPRC, MCV and MCHC of Malabari, crossbred and Attappady black goats

Day of study	THI	VPRC (%)			MCV (fl)			MCHC (g/dL)		
		Malabari	Crossbred	Attappady black	Malabari	Crossbred	Attappady black	Malabari	Crossbred	Attappady black
2nd day	82.64	26.00 ± 1.32	26.45 ± 1.66	26.48 ± 0.89	22.20^{A} ± 0.22	22.70^{A} ± 0.93	21.77^{A} ± 0.61	30.33^{A} ± 1.71	29.56^{A} ± 1.27	30.45^{B} ± 0.99
32nd day	83.71	25.26 ± 1.63	26.75 ± 1.76	25.38 ± 2.04	24.02^{A} ± 0.44	24.08^{A} ± 0.31	23.80^{B} ± 0.28	37.60^{B} ± 2.27	37.25^{B} ± 2.23	35.58^{C} ± 0.94
60th day	82.94	30.21 ± 2.02	28.58 ± 1.40	27.78 ± 0.67	34.27^{B} ± 1.63	34.96^{B} ± 0.99	34.67^{C} ± 0.39	29.10^{A} ± 1.77	28.45^{A} ± 1.02	25.80^{A} ± 0.59

Means bearing same superscript within a columns (A-C) do not differ significantly ($p<0.05$) (n=6)

al. (2015) and Habibu *et al.* (2017), where they found higher TLC levels with an elevated THI. As leucocytes are engaged in immune system, under thermal stress the immune system becomes activated (Okoruwa, 2014), thereby increasing the TLC.

In the present study, in Attappady black goats, mean TLC levels on 2nd day were increased and then steadily decreased when THI was high suggesting a partial adaptation to the heat stressed conditions. Whereas, crossbred goat breeds maintained a steady TLC level during entire study period, showing that the stress had not affected the immune functions. In the case of Malabari goats there was a drastic change in TLC indicating heat stress induced immune system activation.

Haemoglobin (Hb)

Significant difference in Hb concentration was not observed between breeds. However, mean Hb level was significantly increased in Crossbred goats and Attappady black goats when IT and THI were at

peak. At the same time Malabari goats showed statistically non significant difference in Hb concentration which might be due to relatively decreased number of RBCs in Malabari goats on the 32nd day. The observation was in accordance with Alam *et al*. (2011), Bhatta *et al*. (2014), Okoruwa (2014) and Habibu *et al.* (2017) who found an elevated Hb in goats in the afternoon than in the morning which could be due to high demand for oxygen which in turn necessitated high concentration of red blood cells to support respiratory activity under heat stress condition.

Volume of Packed Red Cells (VPRC)

No significant difference was noticed among the VPRC levels in breeds in the experimental period. A lower VPRC levels were recorded in breeds during high IT and THI. Observations of Abdelatif *et al*. (2009) supported the present study who recorded the decrease in VPRC in Nubian goats during summer which might be due to the lowered thyroid hormone levels in summer and that would be affecting the synthesis of RBCs as thyroid hormone level was crucial for erythropoiesis.

Mean Corpuscular Volume (MCV)

Significant difference was not observed between the breeds. A steady increase in MCV value was noticed in Attappady black goats from 2nd day whereas in Malabari goats and crossbred goats from 32nd day onwards. This emphasised the fact that adaptational alterations in volume of RBC were taking place most effectively in Attappady black goats compared to other two breeds to counteract the numerical changes in the RBC or to increase the O_2 carrying capacity. This was in agreement with the findings of Abdelatif *et al*. (2009) who found a decreased MCV values during summer which could be related to the inverse relationship of number and volume of erythrocytes.

Mean corpuscular haemoglobin concentrations (MCHC)

No significant difference was noticed in MCHC levels between breeds. A higher MCHC level was recorded in all breeds during high THI. The MCHC had increased during peak summer to meet the increased O_2 demand of the body. Similarly, Olayemi *et al*. (2015) found an increased level of MCHC in goats during summer. The results of the study indicated that the average erythrocyte cell size and haemoglobin content per erythrocyte were influenced by the THI and the amount of Hb relative to the size of the cell increased with increase in THI.

Conclusion

The mean TLC showed an increasing trend for Malabari goats during the entire experimental period. The mean Hb levels were significantly increased in all the breeds when IT and THI were at peak on 32nd day indicating increased oxygen demand due to thermal stress. The MCV values were significantly lowered in Attappady black and MCHC values were increased in all the animals from 2nd to 32nd day of study indicating adaptive alterations in the haemogram suggestive of the impact of impact of thermal stress

Acknowledgement

The authors are grateful to the Kerala Veterinary and Animal Sciences University for providing the research facilities to complete this study.

Conflict of interest

The authors declare that they have no conflict of interest.

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