B-4700
[1-4]

RESEARCH ARTICLE Indian Journal of Animal Research

Effect of Seasons on Physiological Responses in Sahiwal and Crossbred Cows

J. Sai Prasanna, S.T. Viroji Rao, M. Gnana Prakash, Suresh Rathod[1], P. Kalyani[2], B. Rajith Reddy

10.18805/IJAR.B-4700

ABSTRACT

Background: Growing demand for improving milk production and rising temperatures due to global warming has increased the thermal load on dairy animals. Physiological parameters such as respiration rate and body temperature mainly determine the adaptability of animals to climate stress. During genetic adaptation, *Bos indicus* cattle have acquired thermo tolerant genes and when exposed to heat stress conditions, the *Bos indicus* cattle have lower respiration rates and rectal temperatures than *Bos taurus* animals. The present study was aimed to study the effect of seasons on the physiological responses in Sahiwal and crossbred cows.

Methods: A total of 50 crossbred cows maintained at Military dairy Farm, Secunderabad and 50 Sahiwal cows maintained at Livestock Farm Complex, College of Veterinary Science, Rajendranagar, PVNRTVU were utilized for the present investigation. The study was conducted during summer (THI = 83.71±0.01), rainy (THI = 71.37±0.01) and winter (THI = 66.69±0.01) seasons. Changes in respiration rate (RR), rectal temperature (RT) and heat tolerance coefficient (HTC) were observed in different seasons in Sahiwal and crossbred cows.

Result: RR (breaths/ min) in Sahiwal cows during summer, rainy and winter were 28.56±0.38, 23.38±0.38 and 20.54±0.38 respectively whereas RR (breaths/ min) in crossbred cows were 44.58±0.38, 25.94±0.38 and 21.90±0.38 respectively. In Sahiwal cows RT (°C) during summer, rainy and winter were 38.52±0.03, 38.23±0.03 and 38.13±0.03 respectively whereas RT (°C) in crossbred cows were 39.22±0.02, 38.72±0.03 and 37.80±0.03 respectively. The magnitude of increase in RR, RT and HTC were found to be higher during summer compared to other seasons in both Sahiwal and crossbred cows. It was observed that Sahiwal cows are less sensitive to heat stress and are better able to regulate their body temperature than crossbred cows when environmental temperature increases during summer. The HTC values were lower in Sahiwal cows in all the seasons studied indicating better thermo tolerance when compared to the crossbred cows.

Key words: Crossbred cows, Heat tolerance coefficient, Respiration rate, Rectal temperature, Sahiwal.

INTRODUCTION

One of the greatest challenges faced by livestock keepers around the world is heat stress. Heat stress occurs when any combination of environmental factors cause the effective temperature to be higher than the animals Thermo Neutral Zone. *Bos taurus* cattle experience significant physiological modifications when exposed to prolonged and continuous periods of elevated heat and humidity (Beatty *et al*., 2006). These changes persist for a few days even after the heat stress conditions have settled. *Bos indicus* also experience similar but less marked physiological changes as they are better able to regulate their body temperature in response to heat stress than *Bos taurus* breeds (Dalcin *et al*., 2016).

Heat stress in dairy cattle can be measured because there is a change in metabolic rate of normal equilibrium in response to change in ambient temperature. The specific manifestations of the stress, such as change in body temperature, heart rate and respiration can be measured because the animal responds functionally to maintain homeostasis.

During genetic adaptation, *Bos indicus* cattle have acquired thermo tolerant genes (Hansen, 2004) and thus have a higher degree of thermo tolerance compared to *Bos taurus* animals. When exposed to specific heat stress conditions, the genetic adaptation enables *Bos indicus* cattle to have lower respiration rates and rectal temperatures than *Bos taurus* animals (Gaughan *et al*., 2000; Pereira *et al.,* 2014). Understanding the physiological mechanisms of

Department of Animal Genetics and Breeding, College of Veterinary Science, Rajendranagar, Hyderabad Hyderabad-500 030, Telangana, India.
[1]Department of Livestock Farm Complex, College of Veterinary Science, Rajendranagar, Hyderabad Hyderabad-500 030, Telangana, India.
[2]Department of Veterinary Biotechnology, College of Veterinary Science, Rajendranagar, Hyderabad-500 030, Telangana, India.

Corresponding Author: J. Sai Prasanna, Department of Animal Genetics and Breeding, College of Veterinary Science, Rajendranagar, Hyderabad Hyderabad-500 030, Telangana, India.
Email: drsaiprasannareddy@gmail.com

How to cite this article: Prasanna, J.S., Rao, S.T.V., Prakash, M.G., Rathod, S., Kalyani, P. and Reddy, B.R. (2021). Effect of Seasons on Physiological Responses in Sahiwal and Crossbred Cows. Indian Journal of Animal Research. DOI: 10.18805/IJAR.B-4700.

Submitted: 02-07-2021 **Accepted:** 14-08-2021 **Online:** 31-08-2021

adaptability may enable the breeders to adopt managerial and nutritional strategies to improve the productive efficiency in high yielding crossbred cows in hot environments.

MATERIALS AND METHODS

Experimental animals

The present study was conducted on 100 cows *i.e.*, 50 Sahiwal cows maintained at Livestock Farm Complex, College of Veterinary Science and 50 HF × Sahiwal crossbred cows maintained at Military dairy Farm, Hyderabad. Both Sahiwal and crossbred herds were provided with standard housing. The animals were given balanced ration comprising of both green and dry fodder. Adequate quantities of concentrates (4-6 kg/cow), based on their maintenance and production requirements were given to the milch animals. Regular deworming and vaccination schedules were followed. The animals were vaccinated against Hemorrhagic Septicemia, Black Quarter and Foot and Mouth diseases. The experimental cows were in different parities ranging from first to fourth parity in Sahiwal and first to sixth parity in crossbred cows. The average total lactation milk yield (TLMY) ranged from 1770 kg in Sahiwal cows to 3000 kg in crossbred cows.

Experimental plan

The experimental design was planned so as to study the effect of seasons *i.e* summer (hot dry), rainy (hot and humid) and winter (cold) on the physiological status of the dairy cows. The respiration rates (RR) and rectal temperatures (RT) were recorded twice daily (8 AM and 2 PM) for 30 days in each of the three seasons from each animal during the months of May (2018) for summer; August (2018) for rainy and from mid December (2018) to mid January (2019) for winter season respectively. The weather data was collected from Agriculture Climate Research Center, ARI, Hyderabad for the same period.

Weather conditions

Daily mean temperature was taken as the mean of maximum and minimum temperatures of the day, during the experimental period in each season. The temperature humidity index was derived from a combination of wet and dry bulb air temperatures recorded for each day and expressed in the formula as per (National Research Council, 1971).

$$THI = 0.72 (W_b + D_b) + 40.6$$

Where,

W_b is wet bulb temperature and D_b is dry bulb temperature in °C.

Physiological parameters

Respiration rate of each animal was recorded by visual observation of inward and outward movement of flank for one minute without disturbing the animal. Rectal temperature was recorded in °C by a clean, lubricated thermometer by gently inserting into the rectum using a twisting motion and left in contact with the rectal mucosa for about two minutes. Heat Tolerance Coefficient (HTC) based on respiration rate and rectal temperature was calculated for each animal using the formula given by Benezra (1954), as detailed below.

$$HTC = \left[\frac{BT}{38.33}\right] + \left[\frac{RR}{23}\right]$$

In the equation, denominator 38.33 (BT/38.33) is defined as the normal body temperature (°C) and the denominator 23 (RR/23) is considered to be the normal respiration rate (breaths/minute) in cattle under ideal conditions. The rectal temperature is taken as representative of the body temperature in the present study. The lower the HTC value determined by the equation, the higher the degree of adaptability.

Statistical analysis

The experimental data obtained from three seasons (summer, rainy and winter) have been subjected to standard methods of statistical analysis. Two way analysis of variance was employed to study the effect of genetic group, season and genetic group * season interaction on the physiological parameters. The mathematical model is as follows.

$$Y_{ijk} = \mu + G_i + S_j + G*S + e_{ijk}$$

Where,

Y_{ijk} = record on n^{th} cow during the j^{th} season under i^{th} genetic group, μ = overall mean, G_i= effect of the i^{th} genetic group (i = 1 and 2 for Sahiwal and crossbreds, respectively), Sj = Effect of j^{th} season (j = 1 for summer, 2 for rainy and 3 for winter season), G*S = Interaction effect of genetic group and season and e_{ijk}= random error assumed to be distributed normally and independently with mean zero and variance σ^2_e.

RESULTS AND DISCUSSION

Weather conditions

The ambient temperature (Ta), temperature-humidity index (THI) and relative humidity (RH) during the experimental period are shown in Table 1. The data indicate that the highest mean value of Tmax (41.24°C) was measured in summer (May) while the minimum mean value was recorded during winter (January). The minimum mean value of RH (44.26%) was measured in May (summer), whereas higher value (78.10%) was recorded in January (winter). The temperature-humidity index (THI) calculated was 83.71 for summer, which indicated a high level of thermal stress on the animals as classified by Habeeb *et al.* (2018). Upadhyay *et al*. (2008) also found that THI > 78 requires greater efforts to dissipate heat resulting in reduced production and reproduction performance in dairy cattle.

Physiological parameters

The means for physiological parameters *viz.* respiration rate (RR), rectal temperature (RT) and heat tolerance coefficient (HTC) recorded are presented in Table 2. The effect of

genetic group and season (THI) was found to be highly significant (P≤0.01) on all the physiological parameters studied.

Respiration rate (RR)

The Sahiwal cows had a lower overall mean respiration rate (24.16 ± 0.35, number/minute) than crossbred cows (30.81 ± 0.35). The *Bos indicus* cattle can maintain lower respiration rates than the *Bos taurus* breeds at all temperatures. In the present study, the mean respiration rates during summer, rainy and winter were 36.57±0.43, 24.66±0.43 and 21.22±0.43 respectively. A lower respiration rate under hot weather identifies animals with lesser discomfort. The respiration rate is a reliable physiological parameter for predicting heat stress in dairy cattle (Dalcin *et al.,* 2016) and increases with THI. Published literature also revealed higher respiration rates in cattle during summer, when THI values increase (Kumar *et al*., 2015; Sailo *et al*., 2015a; Verma *et al*., 2015 and Das, 2014). The increase in respiration rate in summer as compared to other seasons may be due to the more demand for oxygen by the tissues in stressful conditions. In Sahiwal, the mean respiration rates were 28.56 ± 0.38, 23.38 ± 0.38 and 20.54 ±0.38 and in crossbred cows the mean respiration rates were 44.58 ± 0.38, 25.94 ± 0.38 and 21.90 ± 0.38 in summer, rainy and winter seasons respectively. Several authors (Kumar *et al*., 2015; Sailo *et al*., 2015a; Verma *et al*., 2015 and Das, 2014) also reported higher respiration rates of Sahiwal cattle and (Deb *et al.,* 2013; Sailo *et al*., 2015b; Verma *et al*., 2015 and Das, 2014) in HF crossbred cattle during summer as compared to winter season. Increased respiration is an important physiological response, which aids in dissipation of excess body heat by vaporizing more moisture in the expired air (Atkins *et al*., 2018). Therefore lower RR indicates an improved thermo tolerance. The change in the RR during summer season was observed to be higher in crossbreds than the indigenous cows indicating lower thermo tolerance in crossbreds.

Rectal temperature

In the present investigation, the overall means for rectal temperature (°C) were 38.29±0.03 and 38.58 ± 0.03 in Sahiwal and crossbred cows respectively, which were well within the normal physiological range for cattle. Higher rectal

Table 1: Means for maximum and minimum temperatures (°C), dry and wet bulb readings (°C), temperature-humidity index (THI) and relative humidity (%) recorded in various seasons.

Parameter	Summer		Rainy		Winter	
	Mean	S.E	Mean	S.E	Mean	S.E
Maximum temperature	41.24	0.16	29.87	0.36	27.92	0.16
Minimum temperature	21.34	0.35	17.42	0.16	16.02	0.47
Dry bulb reading	35.03	0.71	26.61	0.37	23.02	0.60
Wet bulb reading	24.85	0.29	23.58	0.14	19.19	0.30
THI	83.71	0.01	71.37	0.01	66.69	0.01
Relative humidity	44.26	1.65	78.10	2.24	72.26	0.90

Table 2. Means for physiological parameters in Sahiwal and Crossbred cows.

	n	Respiration rate (breaths/min)		Rectal temperature (°C)		Heat tolerance coefficient	
		Mean	SE	Mean	SE	Mean	SE
Overall	300	27.48	0.15	38.44	0.02	2.20	0.01
Genetic group							
Sahiwal	150	24.16^{b}	0.22	38.29^{b}	0.03	2.05^{b}	0.02
Crossbreds	150	30.81^{a}	0.22	38.58^{a}	0.03	2.35^{a}	0.02
Season							
Summer (THI=83.71)	100	36.57^{a}	0.27	38.87^{a}	0.03	2.60^{a}	0.02
Rainy (THI=71.37)	100	24.66^{b}	0.27	38.47^{b}	0.03	2.08^{b}	0.02
Winter (THI=66.69)	100	21.22^{c}	0.27	37.96^{c}	0.03	1.91^{c}	0.02
Genetic group*Season							
Sahiwal-Summer	50	28.56	0.38	38.52	0.03	2.25	0.02
Sahiwal-Rainy	50	23.38	0.38	38.23	0.03	2.01	0.02
Sahiwal-Winter	50	20.54	0.38	38.13	0.03	1.89	0.02
Crossbreds-Summer	50	44.58	0.38	39.22	0.03	2.96	0.02
Crossbreds-Rainy	50	25.94	0.38	38.72	0.03	2.14	0.02
Crossbreds-Winter	50	21.90	0.38	37.80	0.03	1.94	0.02

Means with dissimilar superscripts differ significantly (P≤0.05).

temperatures (38.96±0.03) were recorded in the summer season (THI=83.71), while the lowest rectal temperatures (37.96±0.03) were recorded in the winter season (THI=66.69). Kumar *et al*. (2015), Sailo *et al*. (2015b), Verma *et al*. (2015) and Das, (2014) also reported higher mean rectal temperature values during summer in purebred Sahiwal and HF crossbred cows. The increase in rectal temperature was observed to be more in crossbreds during summer as compared to Sahiwal cows. Higher rectal temperatures during the summer season may be due to excessive heat production due to increased metabolic rate, especially in lactating cows. The basal metabolic rate of zebu cattle is generally lower compared to *Bos taurus* which may be one reason for maintaining a stable rectal temperature during different seasons and exhibiting increased heat tolerance when exposed to higher ambient temperature during summer season (Dalcin *et al.,* 2016) .

Heat tolerance coefficient

Higher values of heat tolerance coefficients were observed in summer when THI was above 83, as compared to the other two seasons in the present study. Kumar *et al*. (2015), Sailo *et al*. (2015a), Das, (2014) in the animals maintained at Livestock research complex, NDRI, Karnal, Verma *et al*. (2015) in Sahiwal and crossbred cows in the northern region of India and Das, (2014) in the purebred/crossbred cows involving HF as exotic inheritance also reported higher HTC values for crossbreds in summer indicating the lower adaptability of crossbred cows over the indigenous cows which are more thermo tolerant. The indigenous cows thus possess climate-resilient traits and can withstand the high temperatures in the face of climate change.

CONCLUSION

The present study revealed that the magnitude of increase in RR, RT and HTC were higher during summer compared to other seasons in both Sahiwal and crossbred cows. The Sahiwal cows were more thermo tolerant than the crossbreds, which may be due to their adaptation to tropical climates and also due to low metabolic rate attributed to low production levels. Therefore, development and adoption of managerial and nutritional strategies with focus on genetic manipulations may help in reducing the impact of heat stress that affects the production and reproduction performance of high yielding dairy cows in hot environments.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the Director, Military Dairy Farm, Secunderabad and PV Narsimha Rao Telangana Veterinary University for providing the facilities to carry out the research work on Crossbred and Sahiwal cows.

REFERENCES

Atkins, I., Cook, N., Mondaca, M. and Choi, C. (2018). Continuous respiration rate measurement of heat-stressed dairy cows and relation to environment, body temperature and lying time. Transactions of the ASABE. 61: 1475-85.

Beatty, D.T., Barnes, A., Taylor, E., Pethick, D., McCarthy, M. and Maloney, S.K. (2006). Physiological responses of *Bos taurus* and *Bos indicus* cattle to prolonged continuous heat and humidity. Journal of Animal Science. 84: 972-985.

Benezra, M.V. (1954). A new index for measuring the adaptability of cattle to tropical conditions. Journal of Animal Science. 13: 1015.

Dalcin, V., Fischer, V., Daltro, D., Alfonzo, M., Priscila, E., Marcelo, S., Giovani, K., Marcos, S and Concepta, M. (2016). Physiological parameters for thermal stress in dairy cattle Revista Brasileira de Zootecnia. 45: 458-65.

Das, (2014). Identification of SNPs in ATP1A1 Gene and their association with heat tolerance in cattle. M V Sc Thesis submitted to ICAR NDRI, Karnal, Haryana.

Deb, R., Sajjanar, B and Singh, U. (2013). Promotor variants at AP2 box region of Hsp701 affect thermal stress response and milk production traits in Frieswal crossbred cattle. Gene. 9: 37.

Gaughan, J.B., Mader, T.L., Holt, S.M., Sullivan, M.L. and Hahn, G.L. (2000). Heat tolerance of Boran and Tuli crossbred steers. Journal of Animal Science. 77: 2398-2405

Habeeb, A.A., Gad, A.E. and Mostafa, A.A. (2018). Temperature-humidity indices as indicators to heat stress of climatic conditions with relation to production and reproduction of farm animals. International Journal of Biotechnology and Recent Advances. 11: 35-40.

Hansen, P.J. (2004). Physiological and cellular adaptations of zebu cattle to thermal stress. Animal Reproduction Science. 82: 349-60.

Kumar, R., Gupta, I.D., Verma, A., Verma, N., Nishant and Vineeth, M.R. (2015). Single nucleotide polymorphisms in Heat Shock Protein (HSP) 90AA1 gene and their association with heat tolerance traits in Sahiwal cows. Indian Journal of Animal Research. 51: 64-69.

NRC, National Research Council. (1971). A Guide to Environmental Research on Animals. National Academy of Sciences. Washington, D.C.

Pereira, A.M.F., Titto, E.L., Infante, P., Titto, C.G., Geraldo, A.M., Alves, A., Leme, T.M., Baccari Jr, F. and Almeida, J.A. (2014). Evaporative heat loss in Bos taurus: Do different cattle breeds cope with heat stress in the same way? Journal of Thermal Biology. 45: 87-95.

Sailo, L., Gupta, I.D., Verma, A., Chaudhari, M.V., Das, R., Upadhyay, R.C. and Goswami, J. (2015a). Single Nucleotide Polymorphisms in HSP90AB1 gene and its association with thermo tolerance in Jersey crossbred cows. Animal Science Reporter. 9: 43-49.

Sailo, L., Gupta, I.D., Verma, A., Das, R. and Chaudhari, M.V. (2015b). Association of single nucleotide polymorphism of Hsp90ab1 gene with thermotolerance and milk yield in Sahiwal cows. African Journal of Biochemistry Research. 98: 99-103.

Upadhyay, R.C., Singh, S.V and Ashutosh (2008). Impact of climate change on livestock. Indian Dairyman. 60(3): 98-102.

Verma, N., Gupta, I.D., Verma, A., Kumar, R., Das, R and Vineeth, M.R. (2015). Novel SNPs in HSPB8 gene and their association with heat tolerance traits in Sahiwal indigenous cattle. Tropical Animal Health and Production. 48: 175-80.