International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 2258-2262

Received: 25-03-2018
Accepted: 27-04-2018

Sonika Grewal
Ph. D Scholar, Division of Animal Physiology, National Dairy Research Institute, Karnal, Haryana, India

Anjali Aggarwal
Principal Scientist, Division of Animal Physiology, National Dairy Research Institute, Karnal, Haryana, India

Correspondence
Sonika Grewal
Ph. D Scholar, Division of Animal Physiology, National Dairy Research Institute, Karnal, Haryana, India

Physiological response of periparturient sahiwal and karan fries cows during hot humid and winter seasons

Sonika Grewal and Anjali Aggarwal

Abstract
The study was conducted to investigate the effect of hot humid and winter season on physiological responses in periparturient Sahiwal and Karan Fries cows. A total of 24 cows including six periparturient Sahiwal and six Karan Fries each in hot humid and winter seasons were selected from Livestock Research Centre of ICAR-National Dairy Research Institute, Karnal, India. Observations were taken at weekly intervals from 21st day prepartum to 21st day post partum. The study was conducted during Hot humid (THI=81.11) and winter (THI= 59.5) seasons. The magnitude of increase in respiration rate, rectal temperature, pulse rate and skin temperature were found to be higher during hot humid season compared to winter season in both transition Sahiwal and Karan Fries cattle. The rectal temperature, respiration rate, pulse rate and skin temperature were significantly (P<0.01) different between transition Sahiwal and Karan Fries cows between both the seasons and also physiological responses showed no significant difference between the days relative to calving.

Keywords: Hot humid, karan fries, physiological parameters, periparturient, sahiwal, winter

1. Introduction
Climate change is one of the major threats for survival of various species, ecosystems and the sustainability of livestock production systems across the world, especially in tropical and temperate countries and sustainability in animal production system is largely affected by climate change. Thermoregulation is the balance between heat production and heat loss mechanisms that occur to maintain a relatively constant body temperature. Therefore, imbalance between metabolic heat production inside the animal body and its dissipation to the environment from animal body results to heat stress under high air temperature and humid climate. Thermal stress on animals includes both heat stress during summer season and cold stress during winter season (Silanikove and Gutam, 1992) [22]. Thermal stress is a major concern for farm animals. Zebu cattle have been shown to have higher thermoregulatory ability compared to cattle of European origin (Pereira *et al.*, 2014) [17] because it reduce heat storage by reducing metabolic heat production and increase in the heat loss capacity to the environment (Hansen, 2004) [12]. Low metabolic rates of zebu cattle resulting from reduced growth rates and milk yields is a major contributing factor to their thermotolerance ability compared to European breeds (Hansen, 2004) [12] therefore in tropical countries Zebu breeds (*Bos indicus*) of cattle are better adapted to heat stress than European breeds (*Bos taurus*) (Beatty *et al.*, 2006; Gaughan *et al.*, 1999) [2, 11]. Animals are exposed to a wide variety of environmental factors during different seasons of the year which have marked effect on the production parameters, physiological parameters as well as metabolic functions of animal body. Disturbance in behavior, feed efficiency, health and performance though effects of thermal stress but it varies according to breeds, production levels and prior experience due to decline in dry matter intake (Aggarwal and Singh, 2010) [1]. The ability of an animal to withstand the climatic stressors under heat stress conditions has been assessed physiologically by means of changes in body temperature, respiration rate and pulse rate and that are related to the animal's ability or inability to efficiently cope with acute or chronic hot conditions (Leagates *et al.*, 1991; Sethi *et al.*, 1994) [16, 21]. Physiological parameters like respiration rate, body temperature, heart rate and skin temperature respond immediately to the environmental stressor and therefore reflect the degree of stress imposed on animals (Bianca, 1965) [6]. These physiological responses during extreme environment have been used as a measure of dairy

cow comfort and adaptability evaluation and heat tolerance of the animals are mainly determined by the physiological parameters (Roman- Ponce *et al*., 1977) [19]. Physiological tolerance of dairy cows is a strong determinant of the environmental conditions in which they inhabit. Therefore, present study was planned to study the physiological responses in hot humid and winter seasons in periparturient Sahiwal and Karan Fries cows.

2. Materials and methods

Ethical approval

The experimental design and procedure were carefully planned and approved by the Institutional Animal Ethics Committee constituted as per the article no. 13 of the CPCSEA rules, laid down by Govt. of India.

Location and climatic conditions of the study area

The present study was carried out at the Climate Resilient Livestock Research Centre, NDRI, Karnal which is located in the arid to semi-arid region of the country at longitude 76.9905° E and the latitude of 29.6857° N and at an elevation of 243m above mean sea level. The maximum ambient temperature in summer goes up to 45 ºC and minimum temperature in winter comes down to 0 ºC with a diurnal variation of 15-20 ºC.The annual rainfall in this area ranges from 600-750 mm with an erratic distribution throughout the year.

Selection and management of Animals

The study was conducted on 24 cows including six periparturient Sahiwal and six Karan Fries each were selected in hot humid and winter seasons from Livestock Research Centre of ICAR-National Dairy Research Institute, Karnal. All the experimental animals were maintained as per standard conditions of feeding and management practices followed at farm. The animals were clinically healthy and kept under the same conditions, with appropriate facilities for feeding and watering. All the animals were fed a ration consisting of concentrate mixture and roughages (berseem, maize or jowar fodder as per the availability at the farm). The animals were housed in a custom designed animal shed made up of custom made roofing at the height 7.62 m at the center and 3.81 m at sides and partly open from side, well ventilated and maintained under proper hygienic conditions. The animals had *ad libitum* access to good-quality drinking water.

Recording of physiological parameters

Rectal temperature

Rectal temperature (RT) of all periparturient cows of both the breeds were recorded using digital thermometer by keeping the thermometer in contact with the rectal mucosa for almost a minute. The results are expressed in ºC. The thermometer was cleaned between animals using cotton wool soaked in methylated spirit and lubricated with liquid paraffin.

Respiration rate

Respiration rates (RR) of periparturient cows of both the breeds were recorded from visual observation of inward and outward movement of the flank. One outward and inward movement was counted as one breath and the respiration rates are expressed in breaths per minute

Pulse rate

Pulse rate (PR) of periparturient cows of both the breeds the animals were counted by feeling the pulsation of middle coccygeal artery at the base of the tail by placing the index finger and the results are expressed in pulsations per minute

Skin temperature

The peripheral skin temperature(ST) at different anatomical sites periparturient cows of both the breeds were recorded using non-contact Tele thermometer (Raytek, Model Raynger ST2L, M/s. Surrey Scientific, Surrey, U.K.) by keeping it 2-3 inches away from the surface of the desired site.

Statistical analysis

Data was analyzed by analysis of variance using SAS software, version (9.1) of the SAS system for window, Copyright© (2011) SAS Institute Inc., Cary, NC, USA. The mean values (Mean ±SE) were calculated and the analysis was performed by using General Linear Methods (GLM) procedure of statistical analysis system to find out the significant difference between breeds, seasons and days

3. Results and discussion

Rectal temperature

Rectal temperature (°C) in Transition Sahiwal and Karan Fries cows in hot humid and winter seasons has been presented in Table: 1

Table 1: Rectal temperature (°C) in Transition Sahiwal and Karan Fries cows during hot humid and winter season

Season	Hot humid		Winter	
Days	Sahiwal	Karan Fries	Sahiwal	Karan Fries
-21	38.5^{xp}±0.33	39.0^{yp}±0.27	37.8^{xq}±0.25	37.6^{yq}±0.18
-14	38.6^{xp}±0.52	39.3^{yp}±0.26	37.6^{xq}±0.20	38.1^{yq}±0.19
-7	38.9^{xp}±0.18	39.7^{yp}±0.41	38.3^{xq}±0.12	37.9^{yq}±0.27
0	39.0^{xp}±0.34	40.0^{yp}±0.23	38.0^{xq}±0.21	38.1^{yq}±0.21
7	37.8^{xp}±0.38	39.7^{yp}±40	38.2^{xq}±0.09	38.5^{yq}±0.20
14	38.7^{xp}±0.26	39.4^{yp}±0.37	37.2^{xq}±0.12	38.5^{yq}±0.22
21	39.0^{xp}±0.22	39.4^{yp}±0.20	37.8^{xq}±0.28	38.1^{yq}±0.21

The values are means ±S.E of six observations of six animals

x,y values differ significantly (P<0.01) between rows showing breed effect

p,q values differ significantly (P<0.01) between rows showing season effect

The rectal temperature was significantly (P<0.01) different between breeds of cows and between seasons. Rectal temperatures were showed no significant difference between the days relative to calving and were found to be higher in hot humid as compared to winter season. Body temperature is a sensitive indicator of physiological responses to heat stress in the cow because it is nearly constant under normal conditions. Monitoring of rectal temperature (RT) for 5 to 10 days after parturition has received remarkable attention in the past two decades because of its cost-effectiveness as well as reliability (Smith *et al.*, 2005; Zhou *et al.*, 2001) [25, 27]. Burfeind *et al.* (2012) [7] identified the factors that influence body temperature in healthy cows in early postpartum. They found that during the hot period, mean rectal temperature was significantly higher than the moderate conditions, which may be due to the greater impact of Temperature Humidity Index (THI) on body temperature under hot environmental conditions than under moderate ones. They observed that there is correlation between temperature Humidity Index and rectal temperature. Bhan *et al.* (2012) [5] found that there was significant higher rectal temperature during hot humid season compared to hot dry, spring and winter seasons in growing and adult Sahiwal cattle. Various studies also suggest that rectal temperature is an indicator of thermal balance and may

be used to assess the adversity of the thermal environment which can affect the growth, lactation, and reproductive performance of dairy cows. The interaction between rectal temperature and cattle performance form a complex interrelationship which affects the dissipation of body heat **(**Rejeb *et al*., 2016) [18]. Thatcher *et al.* (2010) [26] reported that cows may be considered stressed by hot environmental temperature, when RT was above 39.2 ˚C and respiration rate exceeds 60 Insp. /min. In present study rectal temperature of Karan Fries cows ranged between 39.0 ˚C and 40.0 ˚C, indicating that Karan Fries cows were more under stress compared to Sahiwal cows.

Respiration rate

Respiration rate (breaths/minute) in Transition Sahiwal and Karan Fries cows in hot humid and winter seasons has been presented in Table: 2

Table 2: Respiration rate (breaths/min) in Transition Sahiwal and Karan Fries cows during hot humid and winter season

Season	Hot humid		Winter	
Days	Sahiwal	Karan Fries	Sahiwal	Karan Fries
-21	38.66^{xp}±0.55	48.83^{yp}±0.16	15.00^{xq}±0.85	25.00^{yq}±0.966
-14	35.50^{xp}±1.14	48.50^{yp}±0.42	20.50^{xq}±0.34	25.66^{yq}±0.33
-7	34.00^{xp}±0.81	56.50^{yp}±0.76	20.66^{xq}±0.33	24.66^{yp}±0.71
0	38.33^{xp}±0.71	59.83^{yp}±0.76	22.50^{xq}±0.42	27.00^{yp}±0.63
7	35.66^{xp}±0.33	52.66^{yp}±1.14	22.16^{xq}±0.83	24.83^{yp}±0.47
14	34.83^{xp}±0.74	53.50^{yp}±1.20	23.00^{xq}±0.44	22.33^{yp}±0.61
21	35.50^{xp}±0.92	53.33^{yp}±1.66	21.83^{xq}±0.65	23.50^{yp}±0.67

The values are means ±S.E of six observations of six animals
x,y values differ significantly (P<0.01) between rows showing breed effect
p,q values differ significantly (P<0.01) between rows showing season effect

The respiration rate was significantly (P<0.01) different between breeds and seasons. Respiration rate were significantly (P<0.01) different between both the seasons. Respiration rate were showed no significant difference between the days relative to calving and was found to be higher in hot humid as compared to winter season. Heat stressed cows increased thermal regulatory reactions in order to maintain heat balance (Ben Younes *et al*., 2011) [3]. Increased respiration rate is an important thermoregulatory response to heat stress. It helps in dissipation of excess amount of body heat by vaporizing more moisture in the expired air (Beatty *et al*., 2006) [2]. Hence, reduce respiration rate indicates an improved thermotolerance. Dalcin *et al*.(2016) [8] reported that RR was the best indicator of heat stress among rectal temperature (RT), heart rate (HR), respiratory rate (RR), and panting score (PS). Singh *et al*. (2014) [23] reported that higher THI score during hot-humid season which significantly increased respiration rate of cows compared to hot dry and winter season. Singh and Upadhyay (2009) [24] observed higher respiration rate with an increased in ambient temperature and relative humidity. Increase in respiratory frequency may be used an index of discomfort in large animals. Under hot conditions, the increase in respiration rate varied from 2.8 breaths/min (BPM) to 3.3 BPM for each 1^0 C increase in ambient temperature (T_a) in cows. Respiration rate is a useful indicator of the animals heat load. The respiration rate will change according to animal condition, prior exposures, whether ambient temperature is increasing or decreasing and previous cooling strategies (Gaughan *et al*., 2000) [10]. Sailo *et al*. (2017) [20] observed that RR, RT and Heat tolerance coefficient (HTC) were found to be higher during summer compared to spring and winter season in both Sahiwal and Karan Fries cattle.

Pulse rate

Pulse rate (Beats/minute) in Transition Sahiwal and Karan Fries cows in hot humid and winter seasons has been presented in Table: 3

Table 3: Pulse rate (beats/min) in Transition Sahiwal and Karan Fries cows during hot humid and winter season

Season	Hot humid		Winter	
Days	Sahiwal	Karan Fries	Sahiwal	Karan Fries
-21	69.66^{xp}±1.66	79.50^{yp}±0.95	72.33^{qx}±4.14	72.33^{yq}±4.74
-14	72.00^{xp}±1.54	81.16^{yp}±2.80	72.33^{qx}±2.33	71.66^{yq}±2.09
-7	67.66^{xp}±6.00	80.5^{yp}±3.68	72.66^{qx}±1.90	70.00^{yq}±0.51
0	76.66^{xp}±2.76	84.16^{yp}±1.64	76.66^{qx}±1.22	76.66^{yq}±0.61
7	73.00^{xp}±1.77	80.16^{yp}±3.10	68.00^{qx}±2.68	72.33^{yq}±3.66
14	73.00^{xp}±3.17	82.66^{yp}±2.61	69.33^{qx}±1.33	72.66^{yq}±3.48
21	73.33^{xp}±4.18	76.33^{yp}±3.02	59.66^{qx}±3.51	74.33^{yq}±4.01

The values are means ±S.E of six observations of six animals
x,y values differ significantly (P<0.01)between rows showing breed effect
p,q values differ significantly (P<0.01) between rows showing season effect

The pulse rate was significantly (P<0.01) different between breeds and seasons. Pulse rate were showed no significant difference between the days relative to calving. Pulse rate was found to be higher in summer as compared to winter season. Gangwar *et al*. (1988) [9] observed that the pulse rates have significant relation with environmental temperature variation and they observed that average values of pulse rate were higher during summer and lower during winter season. Bhan *et al*. (2012) [5] observed that there was a significantly (P<0.05) higher pulse rate during hot humid season as compared to hot dry, spring and winter season in adult Sahiwal cattle. Koubkova *et al*., (2002) [14] found that there is increase in rectal temperature from 37.3 to 39.3 ^{o}C, respiration rate from 28 to 81 breaths/min and pulse rate from 64 to 81 pulse/min due to high environmental temperature in dairy cows. Similar results found in the present study, pulse rate of Karan Fries cows ranged between 76-84 beats/min in hot humid season, indicating that Karan Fries were more under stress than Sahiwal cows. Summer stress results in increased respiration frequency, pulse rate and rectal temperature which in turn impose higher energy demand upon the animal body (Hooda and Singh 2010) [13]. Respiration rate, pulse rate, rectal temperature, increased during summer season as compared to winter season in Hariana and Sahiwal cattle (Kumar *et al*., 2017) [15]

Skin temperature

Skin temperature (°C) in Transition Sahiwal and Karan Fries cows in hot humid and winter seasons has been presented in Table: 4

Table 4: Skin temperature (°C) in Transition Sahiwal and Karan Fries cows during hot humid and winter season

Season	Hot humid		Winter	
Days	Sahiwal	Karan Fries	Sahiwal	Karan Fries
-21	32.83^{p}±0.51	36.60^{p}±0.21	23.48^{q}±0.40	21.25^{q}±0.35
-14	34.48^{p}±0.28	36.70^{p}±0.45	24.66^{q}±0.51	22.46^{q}±0.26
-7	34.73^{p}±0.40	37.08^{p}±0.26	23.21^{q}±0.55	23.95^{q}±0.92
0	36.16^{p}±0.23	38.16^{p}±0.18	24.51^{q}±0.47	24.78^{q}±0.87
7	35.23^{p}±0.54	36.38^{p}±0.64	24.11^{q}±0.59	22.50^{q}±0.56
14	34.26^{p}±0.63	36.38^{p}±0.82	20.53^{q}±0.29	25.38^{q}±0.44
21	35.10^{p}±0.82	34.31^{p}±0.37	27.26^{q}±0.15	24.86^{q}±0.91

The values are means ±S.E of six observations of six animals
p,q values differ significantly (P<0.01) between rows showing season effect

The skin temperature was significantly (P<0.01) different between winter and hot humid seasons and there was no significantly (P<0.01) changes found between both the breeds and days relative to calving. Skin temperature was found to be higher in summer as compare to winter season. Singh *et al.* (2014) [23] found that higher THI score during hot-humid season which increases (P<0.05) skin temperature as compared to hot dry and winter season in cows. Values of skin temperature showed diurnal variation and were more in the evening than the morning hours in summer season and were normal in winter season. Bhan *et al.* (2013) [4] observed increase in skin temperature (ST) and pulse rate (PR) was observed during summer and hot humid season over the spring season in growing and adult Karan Fries cattle.

4. Conclusion

It was concluded from experiment that physiological parameters were higher during the hot humid season as compared to the winter season in both Periparturient Sahiwal and Karan Fries cattle and physiological parameters are mainly determined the cow comfort, adaptability and heat tolerance. Magnitude of increase in RR, RT, PR and ST were higher in Karan Fries cows. It was observed that Sahiwal cows are better heat tolerant in response to thermal stress than Karan Fries during transition period it may be because of low metabolic rate and better heat dissipation ability in high environmental temperature. Therefore, select and breed cattle that are adapted to extreme environmental conditions so that productivity might be improved.

5. Acknowledgement

The financial grant for the study was provided by National Initiative on Climate Resilient Agriculture, Indian Council of Agricultural Research (NICRA-ICAR), New Delhi. The authors would like to thank the Director, ICAR-NDRI for providing necessary facilities to conduct this research work.

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