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Physiological responses of crossbred dairy cows in the transition period during summer and post-monsoon seasons#

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Abstract

This study aims to measure the physiological responses of sixty clinically healthy peri-parturient crossbred multiparous dairy cows during the summer (February 2022–May 2022) and post-monsoon (October 2021–January 2022) seasons, with 30 animals in each season. Physiological responses such as rectal temperature (°C), respiration rate (per minute), and pulse rate (per minute) of all animals were recorded weekly at 8.00 am and 3.00 pm during the transition period. Three weeks before parturition to three weeks after parturition was considered the transition period. The rectal temperature recorded at 3.00 pm in the summer season significantly ($p < 0.05$) decreased on the day of calving and thereafter returned to pre-partum values, whereas the respiration rate significantly ($p < 0.05$) elevated on the day of calving and thereafter showed no significant variation. Season-wise comparison of all physiological responses in the morning (8.00 am) and evening (3.00 pm) during the transition period showed significantly higher values in the summer season compared to the post-monsoon season. In both seasons evening (3.00 pm) physiological responses were significantly higher than the morning values (8.00 am).

Keywords: *Physiological parameters, transition period, summer, post-monsoon*

The period three weeks before and three weeks after parturition has been referred to as the transition period in a dairy cow (Grummer, 1995). The term transition underscores the tremendous physiological, metabolic and nutritional changes that occur in cows. Body temperature,

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respiratory rate and pulse rate are used as the basis for assessing the health status of cows. Cows with infectious diseases experienced changes in physiological parameters such as respiratory rate and pulse rate (Soedarmanto *et al*., 2022). Rectal temperature monitoring for five to ten days following parturition has drawn significant interest in the past two decades due to its reliability and cost-effectiveness (Zhou *et al*., 2001). Measuring body temperature is one of the most common methods to diagnose infectious diseases in dairy cows during the early puerperium, such as puerperal metritis and clinical mastitis (Smith and Risco, 2005). Extensive and systematic work on physiological parameters of peri-parturient crossbred dairy cows is scanty in Kerala. Hence, the present study is envisaged to estimate the physiological parameters during the transition period and comparison of those during the post-monsoon and summer seasons.

Materials and methods

The present study was carried out in sixty clinically healthy peri-parturient crossbred multiparous (second to sixth calving) dairy cows kept at University Livestock Farm (ULF) and Fodder Research and Development Scheme (FRDS), Mannuthy and Cattle Breeding Farm (CBF), Thumburmuzhy. The study was conducted in the transition period during two seasons, *viz.* post-monsoon (October 2021–January 2022) and summer (February 2022–May 2022) (Joseph, 2011), with 30 animals in each season. All the experimental animals under study were maintained as per the 2016 package of practices recommendations of Kerala Veterinary and Animal Sciences University (KVASU).

Physiological parameters such as rectal temperature (°C), respiration rate (per minute) and pulse rate (per minute) of all animals were recorded weekly at 8.00 am and 3.00 pm during the transition period. Rectal temperature was recorded using a digital thermometer by keeping the thermometer in contact with the rectal mucosa for almost a minute. The results were expressed in °C. The respiration rate was determined by visually observing the flank's inward and outward movement. One outward and inward movement was counted as one breath and the respiration rates were expressed in breaths per minute. The pulse rate of peri-parturient cows was counted by feeling the pulsation of the middle coccygeal artery at the base of the tail by placing the index finger and the results were expressed in pulsations per minute.

The comparison of physiological parameters between seasons was done by using an independent t-test and the comparison between weeks was done by using repeated measures ANOVA followed by the least significant difference (LSD) test. The comparison between morning and evening was done by using paired t-test (Davis, 2014).

Results and discussion

Rectal temperature

The results of the comparison of rectal temperature between the weeks of the transition period and between seasons are shown in Table 1. The comparison of rectal temperature recorded at 8.00 am between the weeks of the transition period during both seasons did not show any significant differences. The rectal temperature recorded at 3.00 pm in the summer season significantly ($p < 0.05$) decreased on the day of calving and thereafter returned to pre-partum values at the first week post-partum, whereas a non-significant result was obtained during the post-monsoon season. Season-wise comparison of rectal temperature in the morning (8.00 am) and evening (3.00 pm) during the transition period showed significantly higher values in the summer season compared to the post-monsoon season.

The results of the comparison of rectal temperature between the weeks of the transition period and between morning and evening irrespective of the season are given in Table 2. Rectal temperature of experimental animals recorded at 8.00 am ($p < 0.05$) and 3.00 pm ($p < 0.01$) declined significantly on the calving day and returned pre-partum values after parturition. Rectal temperature was significantly ($p < 0.01$) lower at 8.00 am than at 3.00 pm during all weeks of the transition period.

Table 1. Comparison of rectal temperature between the weeks of the transition period and between seasons, °C

Weeks	Morning (8.00 am)			Evening (3.00 pm)		
	Post-monsoon	Summer	Season-wise t-value (P-value)	Post-monsoon	Summer	Season-wise t-value (P-value)
-3 Week	38.02 ± 0.05	38.49 ± 0.03	7.274** (<0.001)	38.51 ± 0.06	39.01 ± 0.04[a]	6.829** (<0.001)
-2 Week	37.99 ± 0.06	38.52 ± 0.05	6.704** (<0.001)	38.48 ± 0.06	39.01 ± 0.05[a]	6.468** (<0.001)
-1 Week	38.05 ± 0.07	38.54 ± 0.04	6.433** (<0.001)	38.55 ± 0.08	39.03 ± 0.03[a]	5.792** (<0.001)
0 Week	37.92 ± 0.07	38.35 ± 0.05	4.850** (<0.001)	38.38 ± 0.08	38.83 ± 0.05[b]	4.627** (<0.001)
1 Week	38.03 ± 0.08	38.49 ± 0.06	4.772** (<0.001)	38.47 ± 0.09	39.01 ± 0.06[a]	5.041** (<0.001)
2 Week	38.09 ± 0.10	38.52 ± 0.07	3.566** (0.001)	38.56 ± 0.11	39.03 ± 0.06[a]	3.590** (0.001)
3 Week	38.21 ± 0.11	38.50 ± 0.07	2.250* (0.028)	38.63 ± 0.10	39.01 ± 0.06[a]	3.169** (0.002)
F-value (P-value)	2.569[ns] (0.074)	2.341[ns] (0.063)		2.072[ns] (0.112)	3.061* (0.028)	

*** Significant at 0.01 level; * Significant at 0.05 level; ns non-significant*

Means having different letters as superscripts differ significantly within a column

Rectal temperature was significantly ($p < 0.01$) lower at 8.00 am than at 3.00 pm during the different weeks of the transition period. It is due to the fact that cattle's body temperature shows a pronounced circadian rhythm, with a maximum in the late afternoon and a minimum in the morning (Kendall and Webster, 2009). Rectal temperature was measured twice daily in 55 cows by Burfeind *et al.* (2011). The authors found that the rectal temperatures were 0.3 to 0.5°C and 0.4 to 0.6°C lower on the day of calving than they were 24 and 48 hours prior, respectively. These findings are in line with the present study. The body temperature might be influenced by the temperature humidity index (THI). Debia *et al.* (2021) and Jisha *et al.* (2021) observed the lowest THI in the morning and highest in the afternoon at Mannuthy, Thrissur, during the period of March to May.

Similar findings were reported by Burfeind *et al.* (2012), who discovered that the mean rectal temperature was significantly higher during the hot period than it was during the moderate period, which may be because the temperature-humidity index has a greater impact on body temperature under hot environmental conditions than it does in moderate ones. In accordance with the present results, Sonika and Anjali (2018) also reported that the rectal temperature of peri-parturient Sahiwal and Karan Fries cows was significantly ($p < 0.01$) different between seasons and was found to be higher in hot humid as compared to the winter season. Patbandha *et al.* (2020) assessed changes in rectal temperature in 68 crossbred cows during the first seven days post-partum. The rectal temperature increased by 1°F in healthy cows in the afternoon compared to the morning. The season significantly affected rectal temperature in the morning and the afternoon; it was higher in the hot, humid season, while similar in the autumn and winter seasons. In hot and humid conditions, the normal rectal temperature ranged from 100.2 to 103.4°F in the morning. These findings were in accordance with the present study. Stevenson *et al*. (2020) reported that the rectal temperatures were higher on days 3, 7 and 14 post-partum than they were at calving, but in the present study rectal temperature recorded at 3.00 pm during the summer season only showed the same trend. Cows that gave birth in the summer tended to have higher rectal

Table 2. Comparison of rectal temperature between the weeks of transition period and between morning and evening, °C

Weeks	Morning	Evening	t-value (P-value)
-3 Week	38.26 ± 0.04[a]	38.76 ± 0.05[a]	40.043** (<0.001)
-2 Week	38.25 ± 0.05[a]	38.75 ± 0.05[a]	27.768** (<0.001)
-1 Week	38.30 ± 0.05[a]	38.79 ± 0.05[a]	24.831** (<0.001)
0 Week	38.14 ± 0.05[b]	38.60 ± 0.06[b]	26.692** (<0.001)
1 Week	38.26 ± 0.06[a]	38.74 ± 0.06[a]	27.362** (<0.001)
2 Week	38.31 ± 0.07[a]	38.79 ± 0.07[a]	21.646** (<0.001)
3 Week	38.35 ± 0.07[a]	38.82 ± 0.06[a]	19.001** (<0.001)
F-value (P-value)	3.766* (0.012)	4.278** (0.005)	

*** Significant at 0.01 level; * Significant at 0.05 level;*

Means having different letters as superscripts differ significantly within a column

temperatures as opposed to those that gave birth in the winter or spring, which is in line with the present findings.

Respiration rate

There were no significant changes in the respiration rate measured at 8.00 am in the morning during the weeks of the transition period for both seasons. There was no significant variation in the respiration rate recorded at 3.00 pm in the post-monsoon season during the transition period. However, during the summer season the respiration rate significantly ($p<0.05$) elevated on the day of calving and thereafter showed no significant variation. Season-wise comparison of respiration rate measurements taken in the morning (8.00 am) and evening (3.00 pm) during the transition period revealed significantly ($p <0.01$) greater values during the summer than during the post-monsoon season. The results are given in Table 3.

Table 4. displays the results of the comparison of respiration rates between the weeks of the transition period and between morning and evening irrespective of the season. During the transition phase, experimental animals' respiration rates recorded at 8.00 am and 3.00 pm did not demonstrate any significant variations. However, the respiration rate was statistically ($p <0.01$) lower at 8.00 a.m. during the all weeks of the transition period than it was at 3.00 p.m.

Singh *et al*. (2014) reported that the respiration rate of cows significantly increased during the hot-humid season due to a higher THI score compared to the hot dry and winter seasons, which is in accordance with the present study. According to Dalcin *et al.* (2016), among the different physiological variables, respiratory rate was the best indicator of heat stress. Sailo *et al.* (2017) conducted a study on Sahiwal and Karan Fries cows, the respiratory rate and rectal temperature were significantly higher in the summer than in the winter and spring. These observations are in agreement with the present study. According to Sonika and Anjali (2018), respiration rates differed significantly ($p <0.01$) between the hot and humid and winter seasons, which is in agreement with the present findings. Respiration rate showed no significant difference between the days relative to calving in the same study which was not in agreement with the present study except for the summer season.

Table 3. Comparison of respiration rate between the weeks of the transition period and also between seasons, breaths/min

Weeks	Morning (8.00 am)			Evening (3.00 pm)		
	Post-Monsoon	Summer	Season-wise t-value (P-value)	Post-monsoon	Summer	Season- wise t-value (P-value)
-3 Week	25.30 ± 0.61	34.30 ± 0.93	8.061** (<0.001)	34.40 ± 0.82	46.00 ± 1.51^{bcd}	6.755** (<0.001)
-2 Week	25.20 ± 0.55	33.60 ± 0.79	8.727** (<0.001)	34.40 ± 0.76	44.97 ± 1.42^{cd}	6.562** (<0.001)
-1 Week	26.20 ± 0.69	33.77 ± 1.04	6.065** (<0.001)	35.63 ± 1.01	45.67 ± 1.66^{c}	5.163** (<0.001)
0 Week	25.63 ± 0.62	35.07 ± 1.06	7.721** (<0.001)	34.77 ± 0.99	47.87 ± 1.76^{a}	6.493** (<0.001)
1 Week	25.27 ± 0.73	34.47 ± 1.10	6.994** (<0.001)	35.43 ± 1.18	47.17 ± 1.78^{ab}	5.494** (<0.001)
2 Week	25.80 ± 1.07	34.67 ± 1.10	5.785** (<0.001)	35.30 ± 1.31	47.07 ± 1.85^{abc}	5.178** (0.001)
3 Week	25.93 ± 0.89	33.93 ± 1.27	5.159** (0.001)	35.40 ± 1.32	46.20 ± 2.06^{abcd}	4.422** (0.002)
F-value (P-value)	0.526^{ns} (0.706)	1.035^{ns} (0.398)		0.674^{ns} (0.564)	2.812* (0.021)	

*** Significant at 0.01 level; * Significant at 0.05 level; ns non-significant*

Means having different letters as superscripts differ significantly within a column

Table 4. Comparison of respiration rate between the weeks of the transition period and also between morning and evening, breaths/min

Weeks	Morning (8.00 am)	Evening (3.00 pm)	t-value (p-value)
-3 Week	29.80 ± 0.81	40.20 ± 1.14	23.827** (<0.001)
-2 Week	29.40 ± 0.73	39.68 ± 1.05	21.495** (<0.001)
-1 Week	29.98 ± 0.79	40.65 ± 1.16	20.796** (<0.001)
0 Week	30.35 ± 0.86	41.32 ± 1.31	18.426** (<0.001)
1 Week	29.87 ± 0.89	41.30 ± 1.31	20.159** (<0.001)
2 Week	30.23 ± 0.95	41.18 ± 1.36	17.583** (<0.001)
3 Week	29.93 ± 0.93	40.80 ± 1.40	18.051** (<0.001)
F-value (P-value)	0.708^{ns} (0.611)	2.001^{ns} (0.096)	

*** Significant at 0.01 level; ns non-significant*

Means having different letters as superscripts differ significantly within a column

Pulse rate

The comparison of pulse rate between the weeks of the transition period and between seasons is presented in Table 5. Pulse rates taken in the morning (8.00 am) and evening (3.00 pm) during the weeks of the transition period in both seasons did not show any significant differences. Season-wise comparison of pulse rate in the morning (8.00 am) and evening (3.00 pm) during the transition period showed significantly higher values in

Table 5. Comparison of pulse rate between the weeks of the transition period and between seasons, beats/min

Weeks	Morning (8.00 am)			Evening (3.00 pm)		
	Post-monsoon	Summer	Season-wise t-value (P-value)	Post-monsoon	Summer	Season-wise t-value (P-value)
-3 Week	63.87 ± 0.67	66.37 ± 0.97	2.116* (0.039)	68.40 ± 0.79	71.17 ± 1.12	2.017* (0.048)
-2 Week	63.10 ± 0.84	66.53 ± 0.85	2.880** (0.006)	67.93 ± 0.90	71.23 ± 0.97	2.504* (0.015)
-1 Week	63.00 ± 0.59	66.03 ± 0.89	2.842** (0.006)	67.93 ± 0.76	71.1 ± 0.92	2.650** (0.010)
0 Week	62.63 ± 0.68	66.07 ± 0.91	3.025** (0.004)	66.90 ± 0.70	71.37 ± 1.01	3.635** (0.001)
1 Week	63.13 ± 0.87	68.03 ± 0.99	3.709** (<0.001)	68.00 ± 0.89	72.87 ± 1.13	3.384** (0.001)
2 Week	62.50 ± 0.97	67.33 ± 1.07	3.354** (0.001)	67.40 ± 1.00	72.23 ± 1.24	3.036** (0.004)
3 Week	62.90 ± 1.08	66.50 ± 1.25	2.179* (0.033)	67.37 ± 1.13	71.13 ± 1.46	2.038* (0.046)
F-value (P-value)	0.517^{ns} (0.736)	1.273^{ns} (0.285)		0.581^{ns} (0.700)	0.928^{ns} (0.445)	

*** Significant at 0.01 level; * Significant at 0.05 level; ns non-significant*

Means having different letters as superscripts differ significantly within a column

Table 6. Comparison of pulse rate between the weeks of the transition period and between morning and evening, beats/min

Weeks	Morning (8.00 am)	Evening (3.00 pm)	t-value (P-value)
-3 Week	65.12 ± 0.61	69.78 ± 0.70	21.594** (<0.001)
-2 Week	64.82 ± 0.63	69.58 ± 0.69	21.333** (<0.001)
-1 Week	64.52 ± 0.57	69.52 ± 0.63	24.130** (<0.001)
0 Week	64.35 ± 0.61	69.13 ± 0.68	23.701** (<0.001)
1 Week	65.58 ± 0.73	70.43 ± 0.78	20.954** (<0.001)
2 Week	64.92 ± 0.78	69.82 ± 0.85	23.387** (<0.001)
3 Week	64.70 ± 0.85	69.25 ± 0.95	19.295** (<0.001)
F-value (P-value)	0.835^{ns} (0.503)	0.781^{ns} (0.538)	

*** Significant at 0.01 level; ns non-significant*

Means having different letters as superscripts differ significantly within a column

the summer season compared to the post-monsoon season.

Table 6. depicts the findings of the pulse rate comparison between morning and evening and between the weeks of the transition phase irrespective of the season. Throughout the weeks of the transition phase, there were no significant alterations in the pulse rates of experimental animals when they were recorded at 8.00 am and 3.00 pm The pulse rate was statistically (p -0.01) higher at 3.00 pm

than it was at 8.00 am during the all weeks of the transition phase.

According to Koubkova *et al.* (2002), dairy cows exposed to high environmental temperatures experienced an increase in pulse rate from 64 to 81 pulses per minute. Kumar *et al.* (2017) examined the seasonal influences on the physiological parameters of Hariana and Sahiwal cows during the winter and summer seasons and reported that the pulse rate was higher during the summer season as compared to the winter season. Sonika and Anjali (2018) reported a significant ($p < 0.01$) increase in the pulse rate during the summer season in peri-parturient cows and no significant difference in pulse rate in the days relative to calving. The above findings are in accordance with the present study.

Conclusion

The present study revealed that the rectal temperature, respiration rate and pulse rate of the dairy cows were affected by the physiological status (pregnancy and lactation) of the cows and weather conditions (ambient temperature). The rectal temperature recorded at 3.00 pm in the summer season significantly ($p < 0.05$) decreased on the day of calving and thereafter returned to pre-partum values, whereas the respiration rate significantly ($p < 0.05$) elevated on the day of calving and thereafter showed no significant variation. Season-wise comparison of all physiological responses in the morning and evening during the transition period showed significantly higher values in the summer season compared to the post-monsoon season. In both seasons evening physiological responses were significantly higher than the morning values.

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Conflict of interest

The authors declare that they have no conflict of interest.

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