The Pharma Innovation Journal 2022; SP-11(2): 1571-1575

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(2): 1571-1575

www.thepharmajournal.com
Received: 01-12-2021
Accepted: 05-01-2022

Atul Singh Rajput
Livestock Production Management Division, Artificial Breeding Research Centre, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Mukesh Bhakat
Livestock Production Management Division, Artificial Breeding Research Centre, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Tushar Kumar Mohanty
ARGO Division, Artificial Breeding Research Centre, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Rubina Kumari Baithalu
ARGO Division, Artificial Breeding Research Centre, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Asheq Ahmed Mir
Livestock Production Management Division, Artificial Breeding Research Centre, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Gayathri S Lal
Livestock Production Management Division, Artificial Breeding Research Centre, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Manmohan Singh Rajput
Livestock Production Management Division, Artificial Breeding Research Centre, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Raju Kumar Dewery
ARGO Division, Artificial Breeding Research Centre, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Nadeem Shah
ARGO Division, Artificial Breeding Research Centre, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Corresponding Author
Atul Singh Rajput
Livestock Production Management Division, Artificial Breeding Research Centre, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Identification of estrus using infrared thermography in indigenous dairy animals

Atul Singh Rajput, Mukesh Bhakat, Tushar Kumar Mohanty, Rubina Kumari Baithalu, Asheq Ahmed Mir, Gayathri S Lal, Manmohan Singh Rajput, Raju Kumar Dewery and Nadeem Shah

Abstract
Estrus identification in dairy animals is always a point of interest as it is well established that the pregnancy rate associated with heat detection rate; therefore in the present study 80 multiparous and 24 cyclic heifers of Sahiwal cows were monitored by digital thermal imaging DarviDTL007 camera during estrus and non-estrus period. The vulval, eyeball, ear and muzzle images of 12 cyclic heifers and 40 cyclic multiparous Sahiwal cows in estrus and a similar number of animals in the non-estrus period were taken. The images were analyzed by Darvi T1 analysis software. The results depicted that the muzzle (2.4 °C and 1.37 °C), eye (0.64 °C and 1.6 °C), ear (1.2 °C and 1.5 °C), and vulva (1.95 °C and 2.41 °C) temperature was found to be significantly ($p<0.05$) higher during estrus period as compared to non-estrus period both in cyclic multiparous and cyclic heifers of Sahiwal cows. Therefore, IRT is an upcoming non-invasive technology that can be used to monitor increases in temperature of Sahiwal cows during estrus.

Keywords: infrared thermography, vulva, muzzle, Estrus, Sahiwal cow

Introduction
The estrous cycle in cattle is 21 days ranging from 18 to 24 days. In Indian conditions, about Rs. 5000-7000 losses occur (in terms of cost of feed, labor, milking, medicine, and veterinary expenses, parallel keeping breeding bull) if one heat is missed without insemination and conception (Madkar *et al.,* 2015) [9]. Effective reproductive management can be achieved if heat detection aids are combined with an expert eye. Sexually mature cows displayed a change in body temperature pattern during estrus. An increase of core body temperature around 1.3 °C on the day of estrus was observed every 21 days (Piccione *et al.,* 2007) [13]. The higher temperature in the vulva area is attributed to increased circulation and vasodilatation of the region, which occurs due to high concentrations of circulating estrogen during estrus, causing edema and vulvar hyperemia (Lamothe-Zavaletha *et al*., 1991; Sumiyoshi *et al*., 2014) [6, 17]. The use of a clinical thermometer to monitor temperature has its own set of challenges and drawbacks, including being stressful for the animal and the worker, the risk of zoonotic disease transmission, and the fact that handling can cause an increase in temperature. The use of non-invasive IRT technology is a recent interest in animals science; temperature change may be increase or decrease in a particular body surface area due to change in blood flow to that particular area under various circumstances (Harper, 2000) [3]. IRT has become an upcoming technology in diagnostic as a supportive tool. In the field of animal science, researchers are exploring the use of Infrared thermography for the identification of estrus in Holstein Friesian cows (Talukder *et al.,* 2014; Hurnik *et al.,* 1985) [19, 4], Sow (Sykes *et al.,* 2012; Bowers *et al.,* 2009; Simões *et al.,* 2014; Lee *et al.,* 2019) [18, 1, 16, 7] and in buffalo (Ruediger *et al.,* 2018) [15]. The point of interest in the present study is the assessment of the change in temperature during estrus using non-invasive IRT technology. In normal or silent estrus, thermography in detecting cows in estrus can improve pregnancy rates, as the temperature during estrus increases significantly (Osawa *et al.,* 2004) [12].

Material and methods
Location of study
The present study was conducted in Livestock Research Centre (LRC), ICAR-National Dairy Research Institute (ICAR-NDRI), Karnal, Haryana, India.

This is a sub-tropical climatic region, and annual minimum-maximum temperature ranges from 4 to 45 °C.

Experimental animals

The present study was conduct on 80 multiparous and 24 cyclic heifers of Sahiwal cows.

Infrared thermography camera and analysis software

In the present investigation, thermographic images of all the animals were captured using hand-held, high image resolution (384 X 288 pixels), digital infrared thermal camera (Darvi DTL007 camera, TAK Technologies Pvt. Ltd). The thermal camera can capture a temperature range of -20 °C to +650 °C. The thermal sensitivity of the IRT camera was < 20 °C with an accuracy of ±2%. Before capturing of IRT image, the camera was adjusted to the ambient conditions. The camera was calibrated to ambient temperature and humidity.The value of emissivity and reflected apparent temperature was kept constant for all the images as 0.96 and 20 °C, respectively, which is recommended for biological tissue analysis based on the manufacturer's recommendation. The surface temperature of each photographic episode was analyzed using thermal image analysis software (Darvi TI analysis software). Before this, unclear thermal images were excluded from the analysis; the maximum temperature of the particular region of the images was recorded and used in the statistical analysis.

Experimental design

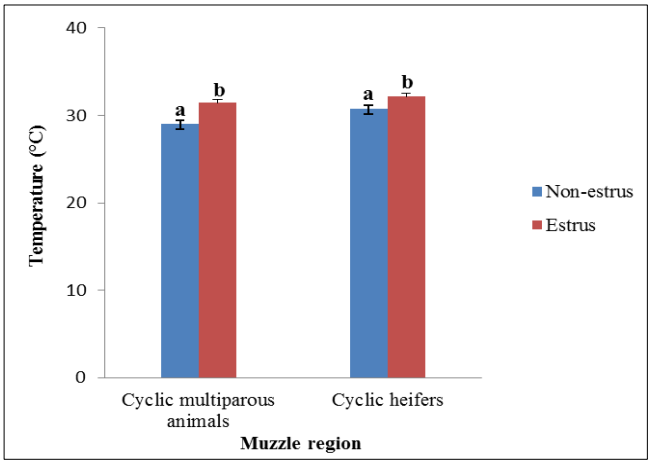
The vulval, eyeball, ear and muzzle images of 12 Sahiwal cyclic heifer and 40 cyclic multiparous animals in estrus and a similar number of animals in non-estrus were taken using a handheld digital thermal imaging DarviDTL007 camera (image resolution: 384X288). Before taking the IRT image, the individual animals were brought to AI shed and restrained in a shaded area to minimize the interference of light, wind velocity, and humidity to adapt to the same conditions. The vulval and muzzle region was cleaned with a clean, dry towel to remove dung and other dirt. After cleaning the animal was rested for 15 to 20 minutes to reduce the stress before thermography. Then thermographic images of the muzzle and vulval areas were taken in cyclic heifers and milch animals in morning hours 8.00 AM to 10.00 AM. The animals were in Estrus and Non-estrus phase was confirmed by an experienced veterinarian working in the Artificial Insemination laboratory having more than 20 years of experience.

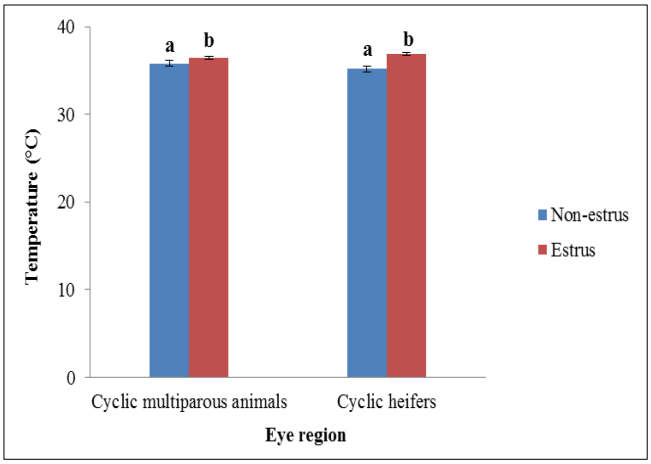
Statistical analysis

The muzzle, eye, ear and vulva temperature of multiparous animals and cyclic heifers during the estrus and non-estrus period was analyzed using paired sample t-test using SPSS 22.0 software (IBM Corporation, Armonk, New York, USA).

Results and Discussion

The Mean±SE (°C) of different body point's temperature in cyclic multiparous animals during the non-estrus and estrus period were 29.01±0.61 and 31.44±0.42 for muzzle, 35.77±0.19 and 36.41±0.17 for eye, 30.32±0.53 and 31.53±0.37 for ear, and 34.73±0.29 and 36.68±0.16 for vulva, respectively. The Mean±SE (°C) of different body point's temperature in cyclic heifers during non-estrus and estrus period were 30.78±0.46 and 32.15±0.48 for muzzle, 35.19±0.34 and 36.87±0.13 for eye, 30.11±0.56 and 31.70±0.53 for ear, and 35.08±0.44 and 37.49±0.11 for vulva, respectively. The muzzle (2.4 °C and 1.37 °C), eye (0.64 °C and 1.6 °C), ear (1.2 °C and 1.5 °C), and vulva (1.95 °C and 2.41 °C) temperature was found to be significantly ($p<0.05$) higher during estrus period than non-estrus period both in cyclic multiparous animals and cyclic heifers. Similar to the present finding Vicentini *et al.* (2020) [21] also reported increased muzzle, eye, and vulva temperature during estrus. The increase of vaginal and vulvar temperature during estrus was also recorded by various researchers (Wrenn *et al.*, 1958; Redden *et al.*, 1993; Kyle *et al.*, 1998) [23, 14, 5]. Similar to the present finding, Talukder *et al*. (2014) [19] and Marquez *et al.* (2019) [10] also reported increase in muzzle, eye and vulva temperature during estrus. In a similar line, Tiwari *et al.* (2021) [20] also reported significantly ($p<0.01$) higher muzzle and vulva temperature of Sahiwal cows during estrus (34.72±0.21 and 39.15±0.15ºC) as compared to non-estrus cows (32.15±0.09 °C and 35.49±0.08 °C). During estrus, the increase in vulva temperature in HF cows (Marquaz *et al.*, 2021), ewe (De Freitas *et al*., 2018), Yorkshire and Landrace crossbred gilts (Sykes *et al.*, 2012) [18], sow (Simões *et al.*, 2014; Lee *et al*., 2019) [16, 7] was also recorded. The increase in temperature during estrus may be due to increased physical activity (Lewis and Newman, 1984; Walton and King, 1986) [8, 22], increases vaginal blood flow due to LH surge and thermogenic effect of progesterone (P4) secreted during the luteal phase contributed to the rise in body temperature (Wrenn *et al.*, 1958; Kyle *et al*., 1998) [23, 5]. The higher temperature in the area of the vulva was attributed due to increased circulation and vasodilatation of the region, due to high concentrations of circulating estrogen during estrus, causing edema and vulvar hyperemia (Lamothe-Zavaletha *et al*., 1991; Sumiyoshi *et al.*, 2014) [6, 17].





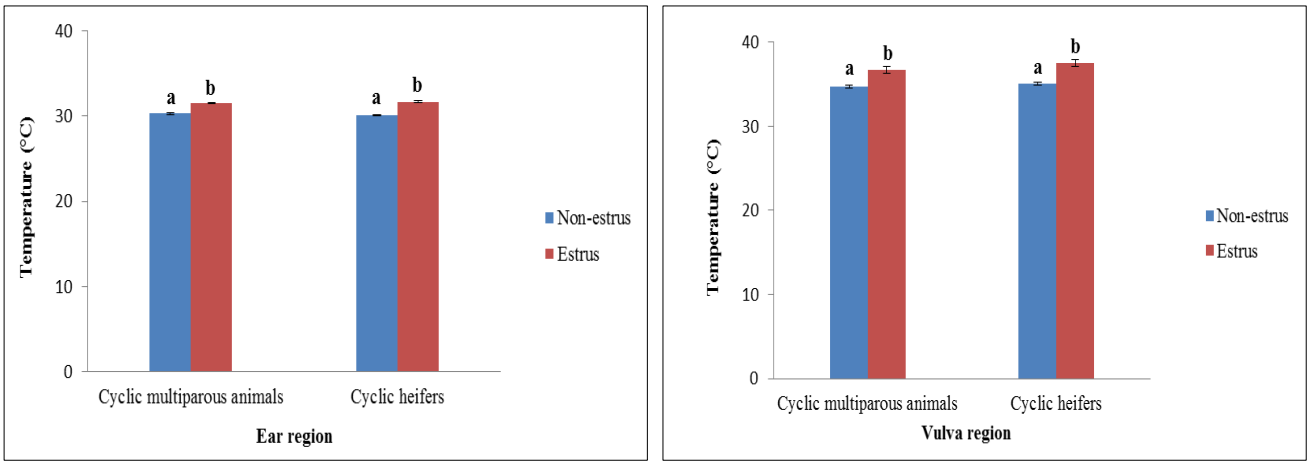
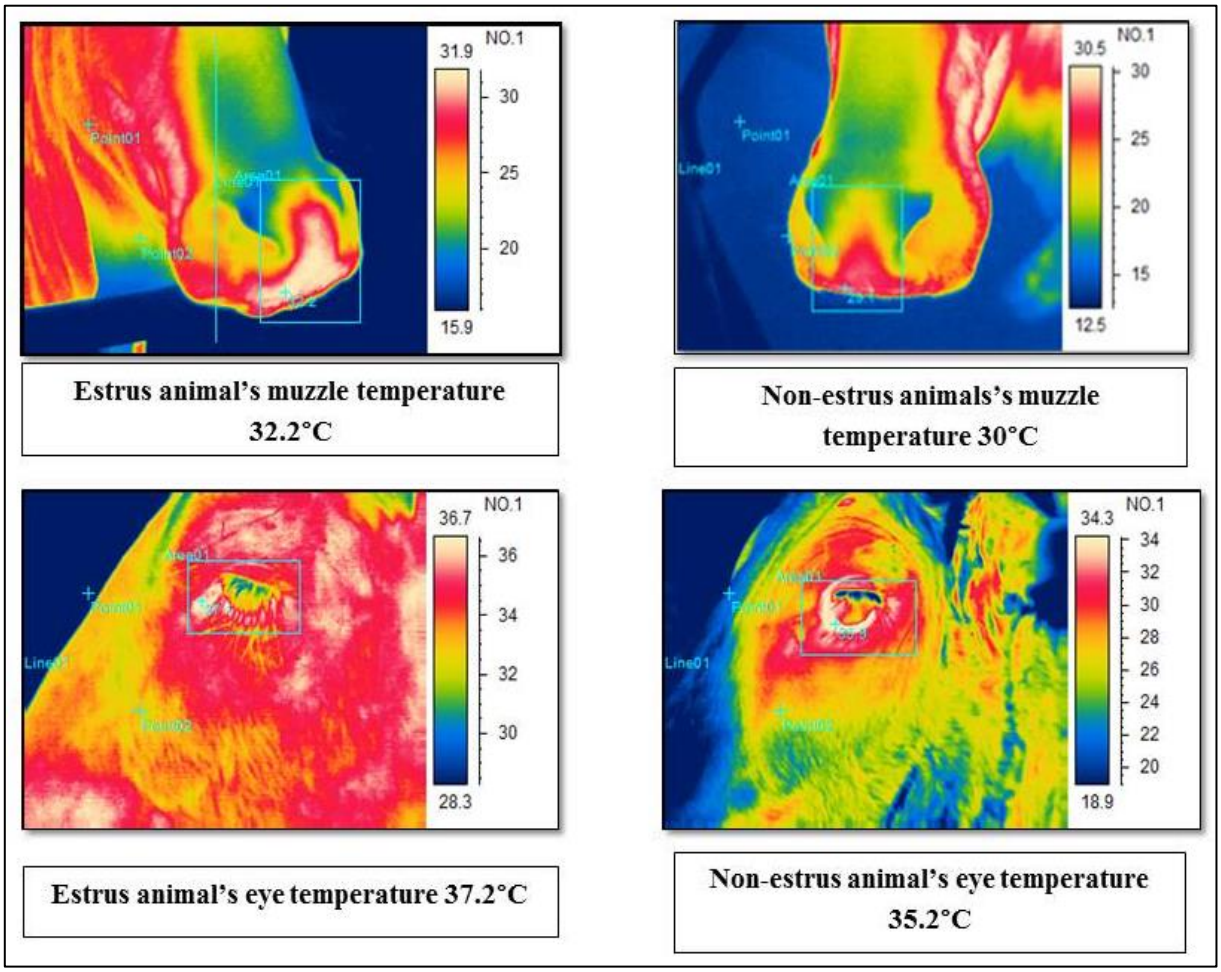


Fig 1: Muzzle, eye, ear, and vulva temperature (°C) of cyclic multiparous animals and cyclic heifers during estrus and non-estrus period. Bars bearing different superscripts differ significantly $^{ab}(p<0.05)$.



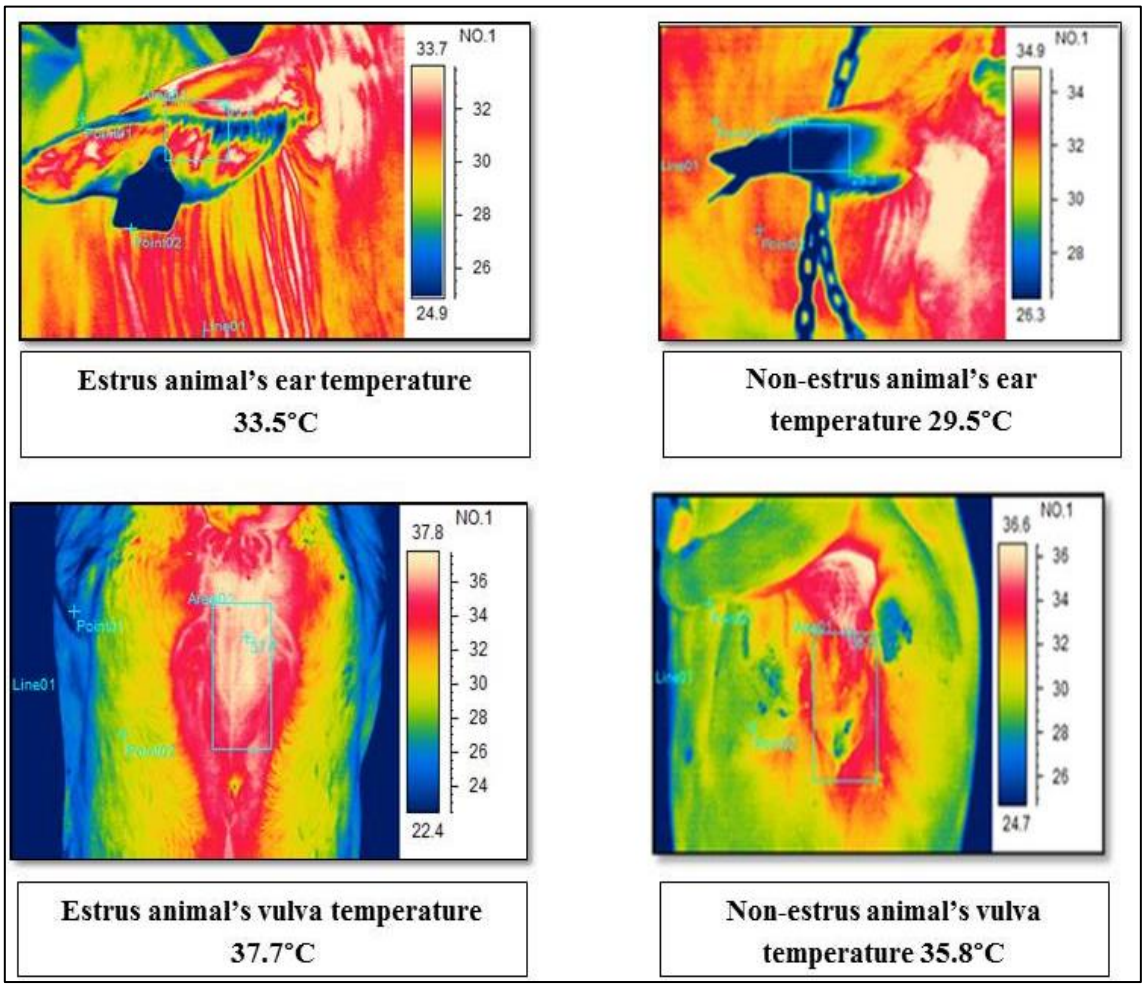


Plate 1: Muzzle, eye, ear and vulva temperature (°C) of Sahiwal cows during estrus and non-estrus period

Conclusion

IRT can monitor increase in muzzle, eye, ear and vulva temperature during estrus in both cyclic heifers and cyclic multiparous animals of Sahiwal cows. IRT can be used as supportive non-invasive tool for estrus monitoring.

Acknowledgment: The author is thankful to Director, ICAR-NDRI, for providing research facility and funding to carry out the research work.

Funding: The research was funded by ICAR-National Dairy Research Institute.

Conflict of interest: The Authors do not have any conflict of interest

References

1. Bowers S, Gandy S, Anderson B, Ryan P, Willard S. Assessment of pregnancy in the late-gestation mare using digital infrared thermography. Theriogenology. 2009;72(3):372-377.
2. de Freitas ACB, Vega WHO, Quirino CR, Junior AB, David CMG, Geraldo AT, *et al*. Surface temperature of ewes during estrous cycle measured by infrared thermography. Theriogenology. 2018;119:245-251
3. Harper DL. The value of infrared thermography in the diagnosis and prognosis of injuries in animals. Proceedings of Inframation, 2000, 115-122.
4. Hurnik JF, Webster ABm De Boer S. An investigation of skin temperature differentials in relation to estrus in dairy cattle using a thermal infrared scanning technique. Journal of Animal Science. 1985;61(5):1095-1102.
5. Kyle BL, Kennedy AD, Small JA. Measurement of vaginal temperature by radiotelemetry for the prediction of estrus in beef cows. Theriogenology. 1998;49(8):1437-1449.
6. Lamothe-Zavaleta C, Fredriksson G, Kindahl H. Reproductive performance of Zebu cattle in Mexico: 1. Sexual behavior and seasonal influence on estrous cyclicity. Theriogenology. 1991;36(6):887-896.
7. Lee JH, Lee DH, Yun W, Oh HJ, An JS, Kim YG, Cho JH. Quantifiable and feasible estrus detection using the ultrasonic sensor array and digital infrared thermography. Journal of Animal Science and Technology. 2019;61(3):163.
8. Lewis GS, Newman SK. Changes throughout estrous cycles of variables that might indicate estrus in dairy cows. Journal of Dairy Science. 1984;67(1):146–152.
9. Madkar AR, Lathwal SS, Mohanty TK, Abdullah M, Santosh K. Estrous confirmation on the basis of behavioral signs of intensity in Crossbred cows. Indian Veterinary Journal. 2015;92(6):60-61.
10. Marquez HP, Ambrose DJ, Schaefer AL, Cook NJ, Bench CJ. Infrared thermography and behavioral biometrics associated with estrus indicators and ovulation in estrus-synchronized dairy cows housed in tie-stalls. Journal of Dairy Science. 2019;102(5):4427-4440.
11. Marquez HP, Ambrose DJ, Schaefer AL, Cook NJ, Bench CJ. Evaluation of infrared thermography combined with behavioral biometrics for estrus detection

in naturally cycling dairy cows. Animal. 2021;15(7):100-205.
12. Osawa T, Tanaka M, Morimatsu M, Hashizume Kand Syuto B. Use of infrared thermography to detect the change in the body surface temperature with estrus in the cow; In SFT/ACT Annual Conference & Symposium. Kentucky, 2004.
13. Piccione G, Caola G, Refinetti R. Annual rhythmicity and maturation of physiological parameters in goats. Research in Veterinary Science. 2007;83(2):239-243.
14. Redden KD, Kennedy AD, Ingalls JR, Gilson TL. Detection of estrus by radio telemetric monitoring of vaginal and ear skin temperature and pedometer measurements of activity. Journal of Dairy Science. 1993;76:713–721.
15. Ruediger D, Yamada FR, PH, Barbosa LGB, Chacur MGM, Ferreira JCP, de Carvalho NAT and Oba E. Effect of estrous cycle phase on vulvar, orbital area and muzzle surface temperatures as determined using digital infrared thermography in buffalo. Animal Reproduction Science 2018;197:54-161.
16. Simões VG, Lyazrhi F, Picard-Hagen N, Gayrard V, Martineau GP, Waret-Szkuta A. Variations in the vulvar temperature of sows during proestrus and estrus as determined by infrared thermography and its relation to ovulation. Theriogenology. 2014;82(8):1080-1085.
17. Sumiyoshi T, Tanaka T, Kamomoae H. Relationships between the appearances and changes of estrous signs and the estradiol-17β peak, luteinizing hormone surge and ovulation during the periovulatory period in lactating dairy cows kept in tie-stalls. Journal of Reproduction and Development. 2014;60(2):106-114.
18. Sykes DJ, Couvillion JS, Cromiak A, Bowers S, Schenck E, Crenshaw M and Ryan PL. The use of digital infrared thermal imaging to detect estrus in gilts. Theriogenology. 2012;78(1):147-152.
19. Talukder S, Kerrisk KL, Ingenhoff L, Thomson PC, Garcia SC and Celi P. Infrared technology for estrus detection and as a predictor of time of ovulation in dairy cows in a pasture-based system. Theriogenology. 2014;81(7):925-935.
20. Tiwari S, Singh Y, Sirohi R, Yadav B, Singh DN, Gurung A, *et al*. Infrared thermographical differentiation of estrus and non-estrus stages of dairy animals. The Pharma Innovation. 2021;10(4):24-28.
21. Vicentini RR, Montanholi YR, Veroneze R, Oliveira AP, Lima ML, Ujita A, *et al*. Infrared thermography reveals surface body temperature changes during proestrus and estrus reproductive phases in Gyr heifers (*Bos taurus indicus*). Journal of Thermal Biology. 2020;92:102662.
22. Walton JS, King GJ. Indicators of estrus in Holstein cows housed in tie stalls. Journal of Dairy Science. 1986;69(11):2966-2973.
23. Wrenn TR, Bitman J, Sykes JF. Body temperature variations in dairy cattle during the estrous cycle and pregnancy. Journal of Dairy Science. 1958;41:1071-1076.