



Assessment of udder skin surface temperature changes in relation to mastitis in crossbred dairy cows in different farms in Kerala

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Citation: Ramesh, R., Biju, S., Mathew, J., Mathew, D.K., Devi, S.S. and Joy, G. 2023. Assessment of udder skin surface temperature changes in relation to mastitis in crossbred dairy cows in different farms in Kerala. *J. Vet. Anim. Sci.* 54(2):604-609

DOI: <https://doi.org/10.51966/jvas.2023.54.2.604-609>

Received: 13.11.2022

Accepted: 07.02.2023

Published: 30.06.2023

Abstract

The aim of the present study was to assess the infrared thermographic profile in relation to mastitis in lactating dairy cows. In this study, 20 lactating crossbred dairy cows each were monitored for a period of 21 days in four dairy farms. The udder skin surface temperature (USST) was recorded using infrared thermography (IRT) during the study period at diurnal time intervals. Milk samples were collected at the time of afternoon milking from each quarter and tested for California Mastitis Test (CMT). It was observed that higher USST was noticed in udders with clinical mastitis followed by non-mastitis and subclinical mastitis, and the skin surface temperature of non-mastitis and clinical mastitis udders were significantly higher than subclinical mastitis affected udders. The results of this study indicate the limitations in the use of IRT of udders for early detection of mastitis across all regions.

Keywords: Infrared thermography (IRT), udder skin surface temperature (USST), mastitis

Mastitis is one of the most common dairy cow diseases, affecting both milk yield and milk quality. Mastitis, which has a high prevalence and incidence rate and is the most common disease affecting dairy cows, is the most expensive for dairy farmers to treat. Subclinical mastitis (SCM) itself is responsible for approximately 70 to 80 per cent of economic losses caused due to mastitis (Sathiyabarathi *et al.*, 2016) and so timely detection of SCM is most important. Amrithapriya *et al.*

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(2021) reported variations in test results in the same animal in detection of true SCM infections when a single test was used. So, they concluded that combination of two or more tests should be employed for accurate screening of SCM. Ali *et al.* (2021) observed that single quarter showed more incidence of SCM (61.81%) followed by two quarters (26.36%).

Infrared thermography (IRT) is a passive, remote and non-invasive technique that allows one to obtain the surface temperature of a body through the infrared radiation of the electromagnetic spectrum that it emits (Eddy *et al.*, 2001). Quirino *et al.* (2022) evaluated the temperature magnitude variation to determine udder health status and mastitis in Holstein-Gir crossbred cows under tropical conditions of Brazilian commercial farms. They observed that the udder temperatures were higher for the clinical mastitis group (37.2 ± 0.7 °C) in relation to the subclinical mastitis (36.6 ± 0.9 °C) and healthy udder (36.3 ± 1.0 °C) groups. Such studies indicated that IRT based mastitis detection, which relied on the measurement of changes in udder skin surface temperature differentials, would be helpful in the early detection of SCM and clinical mastitis in crossbred dairy cows. In this context the present study was undertaken to assess the udder skin surface temperature changes in relation to mastitis in crossbred dairy cows in the humid tracts of Kerala, and to evaluate the efficiency of IRT in detection of mastitis by observing udder skin surface temperature changes.

The study was conducted in four dairy farms of Kerala Veterinary and Animal Sciences University, namely University Livestock Farm (ULF), Base Farm, Livestock Research Station (LRS) and Cattle Breeding Farm (CBF). Twenty lactating crossbred dairy cows preferably at their early lactation with an average body weight of 350 ± 35 kg were selected from each farm. The selected animals were milked twice daily; most of the cows were milked by machine milking. The animals were maintained in an intensive housing system, fed twice a day with concentrate feed and roughage and had free access to drinking water. The study was conducted for a period of 21 days in each farm, and the udder skin surface temperature (USST) of the animals were recorded in diurnal time intervals at 8 a.m., 11 a.m., 2 p.m., and 5 p.m. in a day.

The USST was recorded by thermographic images (Fig. 1) captured using a forward-looking infrared thermography camera (FLIR TG165) displayed in Fig. 2. Prior to capturing the IRT image, the camera was calibrated to ambient temperature, and the temperature measurement was adjusted to degree Celsius and distance to meters. Before taking the udder image, the udder was cleaned to remove dung and other dirt. The udder quarter images were captured from the lateral side for the fore-quarters, and the posterior side for the hind quarters of the udder. For both parts the distance given was approximately 1 m.

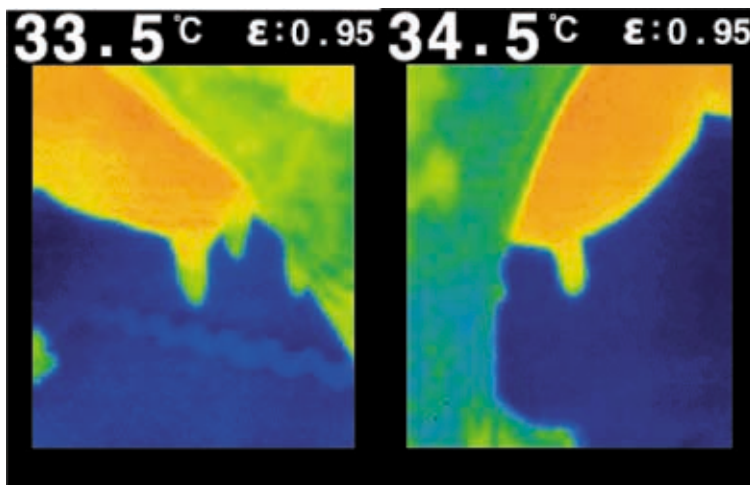


Fig. 1. Thermographic images of udder



Fig. 2. FLIR TG 165 camera model

The study animals with any clinical signs in the udder suggestive of the mastitis like pain, inflammation or redness with or without changes in colour, consistency or viscosity of milk during the study period were identified and recorded as that with clinical infection. Subclinical mastitis affected animals were identified by screening using CMT. A small amount of milk sample from each quarter was squirted into the appropriate quadrant of the paddle after fore stripping, and an equal volume of CMT reagent was mixed into the milk and the reading was interpreted based on Mohanty *et al.* (2015). The animals tested negative in CMT and without any clinical signs in the udder and milk were identified as non-mastitic.

The study indicated that the USST of udders with subclinical mastitis was significantly ($p<0.001$) lower than that of udders with clinical mastitis or non-mastitis. Even though udders with clinical mastitis had higher temperature than that of udders with no mastitis, the difference was not significant. This observation was uniform across all the four farms. The detailed observation of skin surface temperature of non-mastitis and mastitis affected udders of cows in the different farms are presented in Table 1. The temperature difference between skin surface of non-mastitis and mastitis affected udders is depicted in Fig. 1.

The finding of present study was in contrast with Hovinen *et al.* (2008) who advocated the use of IRT. In their study on mastitis induced by *Escherichia coli* endotoxin, they recorded a temperature change of 1 to 1.5 °C in udder skin surface. In another study by Scott *et al.* (2000), endotoxin infusion caused mastitis in udders and the inflammatory response with associated with a 2.3°C rise in temperature. Similarly, with use of thermal camera Pezeshki *et al.* (2011) detected changes of 2 to 3°C in the USST in mastitis induced with *E. coli*. In all the above three studies the mastitis was experimentally induced and was thus a controlled study in which such a high temperature rise was reflected.

In subclinical mastitis quarters, Polat *et al.* (2010) detected a 2.35°C higher skin surface temperature than the healthy quarters, and in contrast our study indicated a significant decline in USST of SCM affected udders in comparison with healthy udders. Though Polat *et al.* (2010) based on his observations identified IRT as a non-invasive tool for screening SCM by measuring USST, had cautioned that the usefulness of IRT in dairy animals with different bodily characteristics and from different environmental situations of air temperature, wind velocity and humidity remain yet to be determined. This statement is relevant with the

Table 1. Comparison of skin surface temperature (Mean \pm SE) of non-mastitis and mastitis affected udders

Farms	Disease status	USST (□)	p-value
ULF	NM (N=1204)	34.65±0.04 ^a	0.000
	SCM (N=404)	34.56±0.06 ^b	
	CM (N=72)	34.99±0.18 ^a	
Base Farm	NM (N=1060)	34.68±0.04 ^a	0.000
	SCM (N=564)	34.56±0.06 ^b	
	CM (N=56)	34.76±0.19 ^a	
LRS	NM (N=860)	34.83±0.04 ^a	0.000
	SCM (N=776)	34.72±0.05 ^b	
	CM (N=44)	34.94±0.24 ^a	
CBF	NM (N=1252)	34.73±0.04 ^a	0.000
	SCM (N=408)	34.57±0.06 ^b	
	CM (N=20)	34.80±0.33 ^a	
N= udder quarter images			

Means with different superscripts (a-b in columns) differ significantly at $p<0.001$.

NM: Non-mastitis; SCM: Sub-clinical mastitis; CM: Clinical mastitis

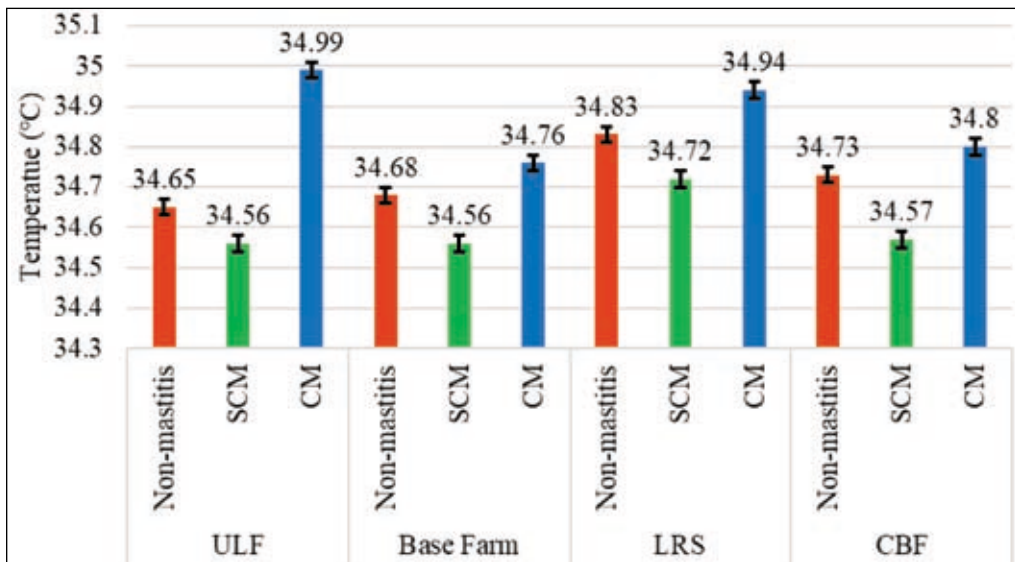


Fig. 3. Temperature (Mean \pm SE) difference between skin surface of non-mastitis and mastitis affected udders

contrasting observation in our present study conducted in a different environment condition, particularly with higher humidity.

In reviewing the different studies on the use of infrared thermography as a non-invasive tool for early detection of mastitis in a dairy animal, Sinha *et al.* (2018) concluded that even though IR thermography is a suitable tool for early detection and screening of mastitis animal, there are some limitations adhered with IRT such as sunlight, moisture, dirt, weather conditions etc., which may influence the accuracy level. So, they also have recommended the need to explore IRT for diagnostic purpose in case of subclinical and clinical mastitis under Indian climatic condition.

Observations were available from studies conducted elsewhere in India such as from Bengaluru and Karnal. Sathiyabarathi *et al.* (2016) investigated USST differentials in Holstein Friesian crossbred cows using IRT and observed an increased temperature of 1.0°C between mastitis affected and unaffected quarters. In another study on the IR thermography to monitor USST in Karan Fries cattle conducted by Sathiyabarathi *et al.* (2018a), they found that affected quarters showed a higher temperature than non-mastitis quarter with a difference of 1.1°C. Sathiyabarathi *et al.* (2018b) also investigated

USST differentials in Deoni cows using IRT and found that the subclinical mastitis-affected quarter showed a 1.51°C higher temperature than the healthy quarters. In order to evaluate the sensitivity and specificity of IRT to identify mastitis in dairy cows kept in a variety of agroecosystems, they suggested further research utilising cows with varying characteristics, such as severity of mastitis, parity, stage of lactation, and seasonal effect. The above studies in India were also conducted in sub-tropical regions with less humidity as compared to the tropical humid climate in the present study.

In agreement with the observation in the present study, Kemp *et al.* (2008) found no significant difference in the mean temperature difference between quarters in the control animals and mean temperature difference between quarters in the mastitis animals. In another study, Porcionato *et al.* (2009) concluded that use of thermal cameras to identify differences in skin surface temperature in different heights of Gir cow udders, but the technique was not found effective in the detection of subclinical mastitis. Furthermore, information on the influence of different stages of lactation, parity, milk yield, breed and season is essential to develop a definite predictive mastitis detection model, and there were no reports available which compared all these parameters.

Summary

The widespread use of cows with high productivity in dairy herds has indirectly increased the environmental sensitivity of dairy cattle. This particularly increased the risk of udder infections resulting in high economic losses. Hence, continuous monitoring of udder health is an important part of successful herd management. The studies in this regard on continuous monitoring of udder health status and establishing appropriate udder health programs has increased in recent years. In this study, no significant increase in skin surface temperature of the clinical and subclinical mastitis udders as compared to healthy udders indicated the influence of some other environmental factors on udder skin surface temperature. The precision of IRT in early detection of mastitis needs to be validated further by conducting detailed studies in different climate zones.

Acknowledgement

The authors acknowledge Kerala Veterinary and Animal Sciences University for providing the financial and infrastructure support for the conduct of the research work.

Conflict of interest

The authors declare that they don't have any conflict of interest.

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