Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(5): 1149-1153

Received: 13-07-2018
Accepted: 14-08-2018

Ziaullah Danish
Artificial Breeding Research Center, Livestock Production and Management Section, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Mukesh Bhakat
Artificial Breeding Research Center, Livestock Production and Management Section, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Adil Rasool Paray
Artificial Breeding Research Center, Livestock Production and Management Section, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Tushar Kumar Mohanty
Artificial Breeding Research Center, Animal Reproduction Gynaeclogy & Obstetrics, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Shabir Ahmad Lone
Artificial Breeding Research Center, Animal Reproduction Gynaeclogy & Obstetrics, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Abdul Rahim
Artificial Breeding Research Center, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Ranjana Sinha
Artificial Breeding Research Center, Livestock Production and Management Section, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Manish Kumar Kushwaha
Artificial Breeding Research Center, Livestock Production and Management Section, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Correspondence
Ziaullah Danish
Artificial Breeding Research Center, Livestock Production and Management Section, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Effect of season, parity and stage of lactation on skin surface temperature (°C) of body, teats and udder in lactating Murrah buffaloes

Ziaullah Danish, Mukesh Bhakat, Adil Rasool Paray, Tushar Kumar Mohanty, Shabir Ahmad Lone, Abdul Rahim, Ranjana Sinha and Manish Kumar Kushwaha

Abstract
The present investigation was carried out in lactating Murrah buffaloes, maintained at Livestock Research Centre, ICAR-NDRI, Karnal, with the objective to analyze the effect of season, parity, and stage of lactation on surface temperature of different body points, teats and udder, using Infrared Thermography (IRT). The thermographic images of different body points, teats and udder were captured during Hot humid, Autumn and Winter season using the hand held digital infrared thermal camera (DarviDTL007). The multiple IRT images were taken at a distance of one meter during morning and evening hours before milking, and best quality images were analyzed using Darvi TI analysis software. Data were analyzed by one way ANOVA using SPSS software. The thermography results showed higher skin surface temperature in buffaloes during hot humid season and at early stage of lactation. The surface temperature of different body points, teats and udder were significantly (P<0.01) higher in hot humid season as compared to other two seasons and the values were observed to gradually decrease in Autumn and then Winter. However, parity was not having any significant effect on teat and udder thermogram.

Keywords: Infrared thermography, season, parity, stage of lactation, surface temperature

Introduction
Skin surface temperature reflects the physiological status of underlying tissues [1]. Infrared thermography (IRT) is able to monitor change in skin surface temperature due to blood circulation and metabolism or any other physiological or pathological reason. IRT is a non-invasive, simple, on-site, and effective method that detects surface heat for assessment of normal and physiological status [2]. A thermal camera absorbs infrared radiation and generates pictorial images based on the amount of heat generated, without causing radiation exposure [3]. The effect of season on production and reproduction performance has been studied well [2, 4], but in different seasons how the body surface temperature changes to cope up with the microclimatic condition needs to be studied more extensively. Researchers have reported a significant effect of season on surface temperature of different body parts among the different seasons. Mostly heat exchange occurs through the skin surface, which is highly correlated with rectal temperature and it is considered an important indicator of the heat load. Accurate and timely detection of body and udder surface temperature of dairy animals is important to prevent the management associated decrease in milk production, quality, and it can also help to make decisions for quick and effective treatment. IRT skin surface temperature assessment can help in early detection of mastitis in dairy cows by monitoring the emitted heat from the udder, generating pictorial images without causing radiation exposure. Early detection of mastitis using non-invasive technology is need of the hour to reduce economic loss to the dairy farmers and dairy industry, as complete eradication of subclinical and clinical mastitis is not feasible [5]. For early detection of mastitis in dairy cows, IRT can also be used as a tool to measure small changes in udder temperature (1.04 °C) [1]. Thus, in the present set of experiments by using infrared thermography, effect of season, parity and stage of lactation on skin surface temperature (°C) of body, teats, and udder in lactating Murrah buffaloes was assessed to have a first hand information about relative fluctuations in skin surface temperature with respect to these factors.

Materials and Methods

Ethical approval

The present study was undertaken after getting necessary approval from the Institute's Animal Ethics Committee.

Animal Selection and Management

All experiments were performed in Murrah buffaloes maintained under uniform management conditions at Livestock Research Centre (LRC), ICAR-NDRI Karnal. Study was conducted during period of July to February, divided in three seasons, hot humid (July to September), autumn (October to mid-December) and winter (Mid December to February). Animals were maintained under loose housing management system. The paddock, which housed the animals under investigation, was large, open and brick paved, and animals were fed ad lib, quality green fodder (Berseem, Maize and Jowar) as per the maintenance requirement and production. The concentrate mixture with 70% TDN and 20% CP was fed as per the milk yield at the rate of 1 Kg for every 2.5 Kg of milk taking average 4% fat. Buffaloes were milked twice a day, by machine milking (Pipeline machine milking system).

Infrared thermal imaging of different body parts and udder

Thermographic images of all animals were captured using hand-held high image resolution (384 X 288) digital infrared thermal (DarviDTL007) camera (Darvi DTL007 camera, TAK Technologies Pvt. Ltd). The thermal camera can record a temperature range of -20 ºC to +650 ºC. Prior to capturing of IRT image, the camera was adjusted and calibrated to the ambient temperature and humidity. The value of emissivity and reflected apparent temperature was kept constant for all the images as 0.96 and 20 ºC, respectively, as recommended for biological tissue analysis. The details about IRT imaging have been mentioned by Kushwaha *et al.* [6].

The IRT method of imaging was carried out in clean body and udder surface of lactating animals in milk parlour. Images were taken twice a day (morning and evening) at a distance of one meter from the focused object for analysis. Orbital images were taken from the lateral side of animals head surrounding the eye including inner canthus and lachrymal glands. Thermographic images of the udder (right fore, right hind, left fore and left hind) and teats (right fore, right hind, left fore and left hind) were taken before milking, and captured from the lateral side for forequarters and posterior or lateral side for hindquarters of the udder. From the lateral side of each animal, thermographic images of milk vein were taken before milking. The surface temperature of different body points such as eye, face, muzzle, forehead, flank (left side) and a coronary band of hind leg were recorded.

Classification of data on teat, udder and body surface temperature

The data on udder and body surface temperature of all experimental animals were classified according to season, parity and stage of lactation.

Season: The period of study was categorized into three seasons on the basis of temperature and relative humidity as follows: Hot humid (July to September), Autumn (October to mid-December) and Winter (Mid December to February) season.

Parity: All animals were classified under different categories to see effect of parity on udder, teats and body surface temperature. Animals with respect to parity were classified into 1^{st}, 2^{nd}, 3^{rd}, 4^{th} parity.

Stage of lactation: The data were classified by stage of lactation of the animals under investigation. For this, the whole lactation was partitioned into three stages as mentioned below:

1. Stage-1: Early stage of lactation (1 to 100 days)
2. Stage-2: Mid-stage of lactation (101 to 200 days)
3. Stage-3: Late stage of lactation (above 200 days)

Results

The results observed have been depicted in Table 1. The various skin surface temperatures recorded during three seasons were significantly ($P<0.01$) higher in hot humid season as compared to other seasons. The skin surface temperature of right fore teat, right hind teat, left fore teat, left hind teat, left fore quarter, left hind quarter, milk vein, leg, eye, face, forehead and muzzle showed significantly ($P<0.01$) higher temperature during hot humid season compared to autumn and winter seasons. Further, there was no significant ($P>0.01$) difference in the temperatures recorded during autumn and winter seasons. The skin surface temperature of flank region showed significant difference among all the three seasons, and was significantly ($P<0.01$) higher in hot humid followed by autumn and lowest in the winter season. Among different seasons, no significant ($P>0.01$) difference was observed between the temperature of the right fore quarter and right hind quarter during the seasons under consideration.

The variations in temperature with respect to parity revealed a non-significant ($P>0.01$) difference in skin surface temperatures of right hind quarter, left hind teat, right hind quarter, milk vein, leg, flank, face, forehead and muzzle. However a significant ($P<0.01$) difference was observed in skin surface temperatures of right fore teat, left fore teat, right fore quarter, left fore quarter, left hind quarter and eyes, between various parities under consideration as shown in Table 1 with different superscripts. The temperatures were observed to be comparatively higher in values during first parity.

The stage of lactation had a non-significant ($P>0.01$) effect on all udder and teat skin surface temperatures. A significant ($P<0.01$) effect was recorded on body surface temperature, except leg and eye. Skin surface temperatures of flank, face, forehead and muzzle showed a significant ($P<0.01$) difference between first and third stage.

Table 1: Mean ±S.E. of skin surface temperature of teats, udder and body parts (°C) in lactating Murrah Buffaloes during various seasons, parity and stage of lactation

Parameter	n	RFT	RHT	LFT	LHT	RFQ	RHQ	LFQ	LHQ	Vein	Leg	Flank	Eye	Face	forehead	Muzzle
Season																
Hot Humid	44	33.90[a] ±0.29	35.28[a] ±0.22	34.05[a] ±0.28	35.62[a] ±0.22	33.66 ±0.30	34.53 ±0.83	34.01[a] ±0.29	35.25[a] ±0.24	33.59[a] ±0.28	31.05[a] ±0.31	34.52[a] ±0.33	36.16[a] ±0.17	34.14[a] ±0.26	32.60[a] ±0.32	33.99[a] ±0.20
Autumn	30	31.74[b] ±0.37	30.99[b] ±0.46	31.20[b] ±0.34	31.45[b] ±0.35	33.42 ±0.24	33.97 ±0.25	32.95[b] ±0.32	33.80[b] ±0.27	31.30[b] ±0.33	25.58[b] ±0.42	28.17[b] ±0.58	35.09[b] ±0.19	30.88[b] ±0.29	26.75[b] ±0.45	30.87[b] ±0.27
Winter	30	31.04[b] ±0.35	30.57[b] ±0.37	30.68[b] ±0.35	31.05[b] ±0.35	33.05 ±0.26	33.54 ±0.27	32.47[b] ±0.32	33.39[b] ±0.27	31.08[b] ±0.28	25.29[b] ±0.34	26.80[c] ±0.42	34.84[b] ±0.18	30.28[b] ±0.25	25.92[b] ±0.36	30.44[b] ±0.23
Parity																
Parity 1	40	33.15[a] ±0.39	33.20 ±0.49	32.98[a] ±0.38	33.20 ±0.48	34.05[a] ±0.30	33.99 ±0.92	33.84[a] ±0.31	34.74[a] ±0.27	32.27 ±0.34	27.87 ±0.61	31.16 ±0.73	35.86[a] ±0.18	32.66 ±0.39	29.40 ±0.63	32.21 ±0.37
Parity 2	32	31.82[b] ±0.39	32.87 ±0.44	31.86[b] ±0.45	33.21 ±0.52	32.63[b] ±0.22	34.25 ±0.25	32.86[b] ±0.37	34.10[ac] ±0.33	31.79 ±0.42	27.82 ±0.63	30.46 ±0.72	35.20[b] ±0.25	31.72 ±0.46	28.32 ±0.72	31.96 ±0.38
Parity 3	20	32.50[ab] ±0.37	32.00 ±0.70	31.84[ab] ±0.45	33.12 ±0.45	33.67[ac] ±0.29	34.35 ±0.20	32.97[ab] ±0.36	34.19[ac] ±0.22	32.90 ±0.36	28.13 ±0.61	29.90 ±0.96	35.37[ab] ±0.24	32.06 ±0.37	29.85 ±0.67	32.23 ±0.47
Parity 4	12	31.68[bc] ±0.77	31.60 ±0.99	31.58[ab] ±0.67	32.42 ±0.83	32.96[cb] ±0.49	33.49 ±0.55	32.88[ab] ±0.51	33.53[bc] ±0.65	31.94 ±0.52	27.04 ±0.94	29.05 ±1.17	35.11[ab] ±0.29	31.20 ±0.67	27.96 ±1.03	31.58 ±0.44
Stage of lactation																
Stage 1 (0 - 100) days	42	32.79 ±0.51	33.02 ±0.68	32.48 ±0.50	33.78 ±0.53	33.51 ±0.31	34.49 ±0.30	33.28 ±0.40	34.40 ±0.22	32.86 ±0.41	28.61 ±0.64	31.73[a] ±0.78	35.69 ±0.24	32.78[a] ±0.44	30.38[a] ±0.69	33.03[a] ±0.31
Stage 2 (101 - 200) days	32	32.33 ±0.42	32.28 ±0.56	31.96 ±0.45	32.52 ±0.53	33.37 ±0.35	34.29 ±0.33	33.01 ±0.37	34.28 ±0.33	31.86 ±0.39	27.46 ±0.65	30.75[ab] ±0.73	35.31 ±0.18	32.13[ab] ±0.39	28.48[b] ±0.68	31.60[b] ±0.40
Stage 3 (201 - 300) days	30	32.29 ±0.29	32.73 ±0.33	32.31 ±0.32	33.02 ±0.38	33.37 ±0.23	33.63 ±0.85	33.42 ±0.25	34.17 ±0.36	31.97 ±0.29	27.47 ±0.51	29.30[b] ±0.66	35.44 ±0.20	31.54[b] ±0.37	28.34[b] ±0.56	31.70[b] ±0.33

Means bearing different superscripts within column differ significantly ($P<0.01$);
n= number of observation; RFT (Right fore teat), RHT (Right hind teat), LFT (Left fore teat), LHT (Left hind teat), RFQ (Right fore quarter), RHQ (Right hind quarter), LFQ (Left fore quarter), LHQ (Left hind quarter).

Discussion

Skin temperature of lactating animals is a good indicator of their health [7], and productive performance [8]. Heat is produced in animals by cellular metabolism [9]. The rate of heat production depends on the metabolic rate which can be affected by change in environmental temperature [9-11]. In a condition, when heat production elevates due to environmental stress, animals dissipate their excess heat through the skin [12, 13]. This exchange of the heat occurs between body core and skin through blood circulation [14, 15]. Heat exchange occurs from the skin to environment in the form of infrared radiation and it is believed that assessing skin temperature could be a good tool to determine animal health and acute stress [16, 17]. In this way, due to technological advancement, IRT can be used to measure the local and temporal changes of temperature of body surface [3, 18]. Moreover, IRT as a method of detecting mastitis can be used for recording temperature changes of udder. It is also rapid, real-time and safe [19, 20]. Chunhe *et al*. [21] reported the normal temperature distribution between rear left (35.57±1.3 °C) and rear right quarters (35.51 ± 1.34 °C) of healthy dairy cows. In the same line, Metzner *et al.* [22] showed the positive correlation between body and udder skin surface temperature of hindquarters and concluded that front quarters might display different patterns of surface temperature, especially since surface temperature may be more or less affected by thermal radiation emanating from the medial aspects of the adjacent hind legs. On the other side more volume of milk in hind quarter may also contribute to higher temperature. Berry *et al*. [1] and Polat *et al.* [23] suggested that management and seasonal influence may exist on udder skin surface temperature. Berry *et al.* [1] have used IRT and based on consecutive measurements of healthy cows and ambient temperature developed a predictive temperature model of the udder skin surface. IRT could be used as a potential non-invasive, quick cow and buffalo-side diagnostic technique.

No previous report was available on the effect of season, parity and stage of lactation on the udder and body surface temperatures of Murrah buffalos. However, Ahirwar *et al*. [24] used the same technique to test the effect of season, age and managemental condition on scrotal thermal profile in male Murrah buffalo. Authors reported that IRT is a good tool to measure skin surface temperature and the season had a significant ($P<0.05$) effect on scrotal and ocular temperature. In accordance with our results, the surface temperatures were observed to be lower in the winter season and highest in the summer season. In crossbred and Deoni cows, Sathiyabarathi *et al.* [7] evaluated the body and udder skin surface temperature and reported that as compared to morning milking, during evening milking, udder skin surface temperature significantly increased by 0.96 to 1.0 °C. As similar to our results, Sathiyabarathi *et al.* [7] also reported the average body and udder skin surface temperature in HF crossbred cow during spring (37.16 ± 0.01; 37.15 ± 0.01 °C), winter (36.39 ± 0.01; 36.40 ± 0.01 °C) and summer (37.80 ± 0.01; 37.79 ± 0.01 °C) season, and the body and udder skin surface temperature was significantly higher during summer (1.1 °C) than spring and winter season. Further, extensive studies are lacking regarding effect of parity or stage of lactation on body surface temperature of lactating Murrah buffalo. However, a few studies in other exotic cattle indicate that parity number, and how often the cows are milked, affect the body temperature [25]. However, in our studies, in Murrah buffaloes, the body temperature was significantly higher in first parity. In similar line, Sathiyabarathi *et al*. [7] reported that parity and milk yield had a non-significant influence on body and the udder surface temperature in HF crossbred and Deoni cows.

IRT could detect minute changes in udder skin surface temperature to state about health status [3]. So, the generated baseline values pertaining to different body points, udder and teats in Murrah buffaloes can be tested for their possible use in the prediction of mastitis or any other disease in buffaloes.

Conclusions

The information on the influence of different stages of lactation, parity and season is essential to develop a definite predictive disease detection model, particularly for mastitis. The present results provide the baseline information about the effect of season, parity and stage of lactation on the udder, teats and body skin surface temperature in Murrah buffaloes. The thermography results showed higher skin surface temperature in buffaloes during hot humid season and at early stage of lactation which require management interventions to maintain their productivity and minimize the incidence of diseases during these critical conditions.

Acknowledgement
First Author extends his sincere thanks to Ministry of Agriculture, Irrigation & Livestock, Government of Afghanistan, Indian Council of Agricultural Research, Ministry of Agriculture & Farmer's Welfare, Government of India, and also Director, NDRI, Karnal for providing necessary facilities to execute the experiments. Support and help of staff members of Livestock Research Center and Artificial Breeding Research Center, NDRI is also acknowledged.

Financial Support
First Author has received funds from Indian Council of Agricultural Research, Ministry of Agriculture & Farmer's Welfare, Government of India in the form of "India-Afghanistan Fellowship Programme, 2016-17".

References

1. Berry RJ, Kennedy AD, Scott SL, Kyle BL, Schaefer AL. Daily variation in the udder surface temperature of dairy cows measured by infrared thermography: Potential for mastitis detection. Canadian Journal of Animal Science. 2003; 83:687-693.
2. Sinha R, Bhakat M, Mohanty TK, Ranjan A, Kumar R, Lone SA *et al*. Infrared thermography as non-invasive technique for early detection of mastitis in dairy animals. A review. Asian Journal of Dairy & Food Research. 2018; 37(1):1-6.
3. Kunc P, Knizkova I, Prikryl M, Maloun J. Infrared thermography as a tool to study the milking process: A review. Agricultura Tropicaet Subtropica. 2007; 40(1):29-32.
4. Yadav HP, Lone SA, Shah N, Verma UK, Dewry RK. Effect of heat stress on reproduction in dairy animals. Journal of Experimental Zoology, India. 2018; 21:623-631.
5. Smith KL. Mastitis control: A discussion. Journal of Dairy Science. 1983; 66:1790-1794.
6. Kushwaha MK, Bhakat M, Mohanty TK, Lone SA, Kumar R, Sinha R, *et al*. Study on semen quality in relation to scrotal surface temperature gradient, testicular covering thickness and scrotal circumference in Murrah bulls. Journal of Pharmacognosy and Phytochemistry. 2018; 7(4):813-817.
7. Sathiyabarathi M, Jeyakumar S, Manimaran A, Pushpadass HA, Sivaram M, Ramesha KP, *et al*. Investigation of body and udder skin surface temperature differentials as an early indicator of mastitis in Holstein Friesian crossbred cows using digital infrared thermography technique. Veterinary World. 2016; 9(12):1386-1391.
8. Das R, Sailo L, Verma N, Bharti P, Saikia J, Kumar R. Impact of heat stress on health and performance of dairy animals: A review. Veterinary World. 2016; 9(3):260-8.
9. Völker J, Johnson MD, Moeller HV, Laws E, Breslauer KJ, Falkowski PG. Universal constant for heat production in protists. Proceedings of the National Academy of Sciences. 2009; 106(16):6696-6699.
10. Li Y, Ito T, Nishibori M, Yamamoto S. Effects of environmental temperature on heat production associated with food intake and on abdominal temperature in laying hens. British Poultry Science. 1992; 33(1):113-22.
11. Polsky LB, Madureira AM, Drago Filho EL, Soriano S, Sica AF, Vasconcelos JL, *et al*. Association between ambient temperature and humidity, vaginal temperature, and automatic activity monitoring on induced estrus in lactating cows. Journal of Dairy Science. 2017; 100(10):8590-8601.
12. Wang W, Song Y, Petrovski K, Eats P, Trott DJ, San Wong H, *et al*. Development of intramammary delivery systems containing lasalocid for the treatment of bovine mastitis: impact of solubility improvement on safety, efficacy, and milk distribution in dairy cattle. Drug design, Development and Therapy. 2015; 9:631.
13. Ahmed BMS, Younas U, Asar TO, Dikmen S, Hansen PJ, Dahl GE. Cows exposed to heat stress during fetal life exhibit improved thermal tolerance. Journal of Animal Science. 2017; 95(8):3497-3503.
14. Collier RJ, Dahl GE, Van Baale MJ. Major advances associated with environmental effects on dairy cattle. Journal of Dairy Science. 2006; 89:1244-1253.
15. Nigel T. Unlocking the secrets of skin blood flow Cable. The Journal of Physiology. 2006; 572(3):613.
16. Soerensen DD, Pedersen LJ. Infrared skin temperature measurements for monitoring health in pigs: a review. Acta Veterinaria Scandinavica. 2015; 3:5-7.
17. Herborn KA, Graves JL, Jerem P, Evans NP, Nager R, McCafferty DJ, *et al*. Skin temperature reveals the intensity of acute stress. Physiology & Behavior. 2015; 152:225-230.
18. Stelletta C, Gianesella M, Vencato J, Fiore E, Morgante M. Thermographic Applications in Veterinary Medicine. In: Prakash RV (ed) Infrared Thermography. In-Tech China. 2012, 117-140.
19. Scott SL, Schaefer AL, Tong AK, Lacasse P. Use of infrared thermography for early detection of mastitis in dairy cows. Canadian Journal of Animal Science. 2000; 80:764-765.
20. Colak A, Polat B, Okumus Z, Kaya M, Yanmaz LE, Hayirli A. Short communication: early detection of mastitis using infrared thermography in dairy cows. Journal of Dairy Science. 2008; 91(11):4244-4248.
21. Chun-He Y, Xian-hong G, Zhenghui CAO, Xiaojun Z, Yue H, Yunxiang L, *et al*. Study on possibility of left and right quarter skin temperature difference as a detecting indicator for subclinical mastitis in dairy cows. Acta Vet Zootech Sin. 2015; 46(9):1663-1670.
22. Metzner M, Sauter-Louis C, Seemueller PW, Klee W. Infrared thermography of the udder surface of dairy cattle: Characteristics, methods, and correlation with rectal temperature. The Veterinary Journal. 2014; 199:57-62.
23. Polat B, Colak A, Cengiz M, Yanmaz LE, Oral H, Bastan A, *et al*. Sensitivity and specificity of infrared thermography in detection of subclinical mastitis in dairy cows. Journal of Dairy Science. 2010; 93:3525-3532.
24. Ahirwar MK, Kataktalware MA, Ramesha KP,

Pushpadass HA, Jeyakumar S, Revanasiddu D, *et al*. Influence of season, age and management on scrotal thermal profile in Murrah bulls using scrotal infrared digital thermography. International Journal of Biometeorology. 2017; 61(12):2119-2125.
25. Smith BI, Risco CA. Management of periparturient disorders in dairy cattle. Veterinary Clinics: Food Animal Practice. 2005; 21:503-521.