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Use of infrared thermography in the assessment of mammary glands and eyeballs in dairy cattle in Western Pará

Uso da termografia infravermelho na avaliação das glândulas mamárias e globo ocular de fêmeas bovinas leiteiras no Oeste do Pará

Uso de termografía infrarroja en la evaluación de glándulas mamarias y globos oculares en ganado lechero en el oeste de Pará

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Abstract

The objective of this work was to perform the thermographic evaluation of the mammary glands and the eyeball of dairy cattle females on a rural property in the municipality of Mojuí dos Campos, in Western Pará. Eight (n = 8) pluriparous Girolando dairy females were used, maintained in a semi-intensive system, with an average age and weight of 7 years and 450 kg, respectively. The females were divided into two experimental groups, Lactating (LACT, n = 4) and Non-Lactating (N-LACT, n = 4). An infrared thermographic camera was used to obtain the surface temperature of the mammary glands (upper, middle and final third region) and the eyeball. Past version 2.16 was used, obtaining mean and standard deviation and analysis of variance with the Anova One-Waye Tukey test (5%). Mean surface temperature was observed in the mammary glands in the LACT and N-LACT group of 40.2ºC±0.8 and 39.6ºC±0.9, 38.9ºC±0.6 and 38.0ºC±0.7, and 37.5ºC±0.6 and 36.8ºC±0.7 in the upper, middle and final third regions, respectively. The females in the N-LACT group had an average temperature of the eyeball of 36.3ºC ± 0.8 and the LACT 37.3ºC±0.8. There was a numerically higher surface temperature in the mammary gland of lactating females, especially in the upper third, and lower temperatures in the final third (teats), however, statistically significant differences were not detected between the groups (P≥0.05). Greater thermal amplitude was found in the middle third of the mammary glands and higher surface temperature in the eyeball region of lactating females. Thus, infrared thermography is a technique capable of pointing out specific regions in the detection of changes in dairy cattle herds.

Keywords: Cows; Mammary gland; Lactation.

Resumo

O objetivo do estudo foi realizar a avaliação termográfica das glândulas mamárias e globo ocular de fêmeas bovinas leiteiras em uma propriedade rural no município de Mojuí dos Campos, no Oeste do Pará. Foram utilizadas oito (n=8) fêmeas leiteiras pluríparas da raça Girolando, mantidas em sistema semi-intensivo, com idade e peso médio de 7 anos e 450 kg, respectivamente. As fêmeas foram divididas em dois grupos experimentais, Lactantes (LACT, n=4) e Não-Lactantes (N-LACT, n=4). Foi utilizada uma câmera termográfica infravermelho

para a obtenção da temperatura superficial das glândulas mamárias (região do terço superior, médio e final) e do globo ocular (região medial). Utilizou-se o programa Past versão 2.16, obtendo-se média e desvio padrão e análise de variância com o teste de Anova One-Waye Tukey (5%). Ao comparar os grupos LACT e N-LACT não foi detectada diferença significativa entre os mesmos (P≥0,05). Foram observadas nas glândulas mamárias temperatura média superficial no grupo LACT e N-LACT de 40,2ºC±0,8 e 39,6ºC±0,9, 38,9ºC±0,6 e 38,0ºC±0,7, e 37,5ºC±0,6 e 36,8ºC±0,7 na região do terço superior, médio e final, respectivamente. As fêmeas do grupo LACT apresentaram temperatura média do globo ocular de 37,3ºC±0,8 e as N-LACT de 36,3ºC±0,8. Foi constatada maior amplitude térmica no terço médio das glândulas mamárias e maior temperatura na região do globo ocular das fêmeas lactantes. Assim, a termografia infravermelho foi capaz de determinar que as fêmeas avaliadas estavam em condições adequadas de conforto térmico ambiental e as modificações fisiológicas decorrentes da lactação não foram capazes de ocasionar elevação da temperatura superficial.

Palavras-chave: Vacas; Lactação; Temperatura; Imagens termográficas.

Resumen

El objetivo del estudio fue realizar la evaluación termográfica de glándulas mamarias y globo ocular de hembras de ganado lechero en una propiedad rural del municipio de Mojuí dos Campos, en el occidente de Pará.Se utilizaron ocho (n = 8) hembras lecheras multirraciales Girolando, mantenido en un sistema semi-intensivo, con edad y peso promedio de 7 años y 450 kg, respectivamente. Las mujeres se dividieron en dos grupos experimentales, lactantes (LACT, n = 4) y no lactantes (N-LACT, n = 4). Se utilizó una cámara termográfica de infrarrojos para obtener la temperatura superficial de las glándulas mamarias (tercera región superior, media y final) y del globo ocular (región medial). Se utilizó la versión anterior 2.16, obteniendo media y desviación estándar y análisis de varianza con la prueba Anova One-Waye Tukey (5%). Al comparar los grupos LACT y N-LACT, no se detectó diferencia significativa entre ellos (P ≥ 0,05). La temperatura superficial media de las glándulas mamarias en el grupo LACT y N-LACT fue 40,2ºC ± 0,8 y 39,6ºC ± 0,9, 38,9ºC ± 0,6 y 38,0ºC ± 0,7, y 37 , 5ºC ± 0,6 y 36,8ºC ± 0,7 en la tercera región superior, media y final, respectivamente. Las hembras del grupo LACT tuvieron una temperatura media del globo ocular de 37,3ºC ± 0,8 y la N-LACT de 36,3ºC ± 0,8. Se encontró una mayor amplitud térmica en el tercio medio de las glándulas mamarias y una temperatura más alta en la región del globo ocular de las hembras lactantes. Así, la termografía infrarroja pudo determinar que las hembras evaluadas se encontraban en

condiciones adecuadas de confort térmico ambiental y los cambios fisiológicos resultantes de la lactancia no lograron provocar un aumento en la temperatura superficial.

Palabras clave: Vacas; Lactancia; Temperature; Imágenes termográficas.

1. Introduction

Dairy cattle farming is highly expressive in the context of world livestock. Brazil occupies the 5th position when comparing with the largest milk producers, being below India, United States, China and Pakistan (FAO, 2016). In a degree of importance in the Brazilian market, milk production is included among the six most prominent products, where the dairy industry actively participates in the generation of jobs and income to the country (Ladeira, 2007, Embrapa, 2016).

As a peculiar characteristic, the national dairy production has great structural diversity. The heterogeneity is demonstrated both in the production systems and in the aspects related to herd feeding and milk quality (Corrêa, 2010, Souza et al., 2009). According to Oliveira et al. (2007), the socioeconomic, cultural and climatic diversity that influences the production systems generates demands for regional studies such as in the dairy chain, which represents more than 80% of the municipalities that work in the Brazilian livestock. Other factors that can influence dairy production are: genetic, nutritional, environmental and health (Teixeira et al., 2010). The genetic improvement of the herd, nutritional management, environmental comfort and sanitary conditions are examples of actions taken by ranchers to improve the productivity of the herd (Patês et al., 2012).

In relation to the health of the dairy herd, mastitis deserves to be highlighted, which can present itself in a clinical and subclinical form because it points to signs of inflammatory processes, causes serious economic losses, in addition to risks of infections (Radostits et al., 2002, Marques, 2006, Tripaldi et al., 2010). Mastitis reduces productivity and should be investigated in herds (Costa, 1998, Santos, 2012) as a guarantee of health in dairy basins in the country. Silva et al. (2019) evaluating the surface temperature of cows with and without mastitis, observed differences in the surface temperature of healthy cows (29.3ºC and 32.2ºC.), With subclinical (33.2ºC and 34.6ºC) and clinical mastitis (34.0ºC and 37.5 ° C). Nogueira et al. (2015) observed that the mammary glands of dairy cows present variations in the surface temperature, from the healthy animal, with clinical and subclinical mastitis, being 38.2ºC, 39.3°C and 37.3°C, respectively.

Palpation is a method of clinical evaluation widely used to examine the mammary glands, evaluating their sensitivity and consistency. Initially, the entire udder is palpated, then the parenchyma of each of the quarters is evaluated and, finally, the ceilings are examined for thickening of the epithelial tissue of the sinus-papillary lining (where the hardening indicates the formation of a thick cord in cisternites) and papillary ducts to identify their permeability and their distal edges of the sinus-lactifer (in cases of galactophorites it is not possible to evaluate the cistern), according to Feitosa (2014).

In the case of mastitis, there is clinical evidence, such as inflammation of the udder and the presence of granules, blood and pus at the time of the black bottom mug test, in addition to the performance of complementary tests used mainly for the detection of subclinical mastitis, such as the California Mastitis Test (CMT), somatic cell count (CCS) and total bacterial (CBT). The culture and isolation of the etiological agent are performed to support efficient treatment strategies for control and prophylaxis (Fonseca and Santos, 2000, Dias, 2007, Lopes, 2015), however, these methodologies require actions of direct contact with the evaluated females.

When mastitis is detected among the indicators, the thermal condition is verified, since increases in the temperature of the mammary gland are strong evidence of inflammatory processes. In animal production, scientific data are sought that support alternatives to increase the productive yield of dairy females (Rodrigues et al., 2010).

For the investigation of changes in surface temperature, thermographic cameras capable of early diagnosis of anomalies in different types of targets have been used. Infrared thermography has been used in veterinary diagnostics because it is a non-invasive and highly accurate technique, as thermograms perform a scanner-like imaging of body surface temperature (Mikail, 2010). It should be noted that the surface temperature of the animals depends on the blood flow and the metabolic rate of the subcutaneous tissues (Nikkhahet et al., 2005).

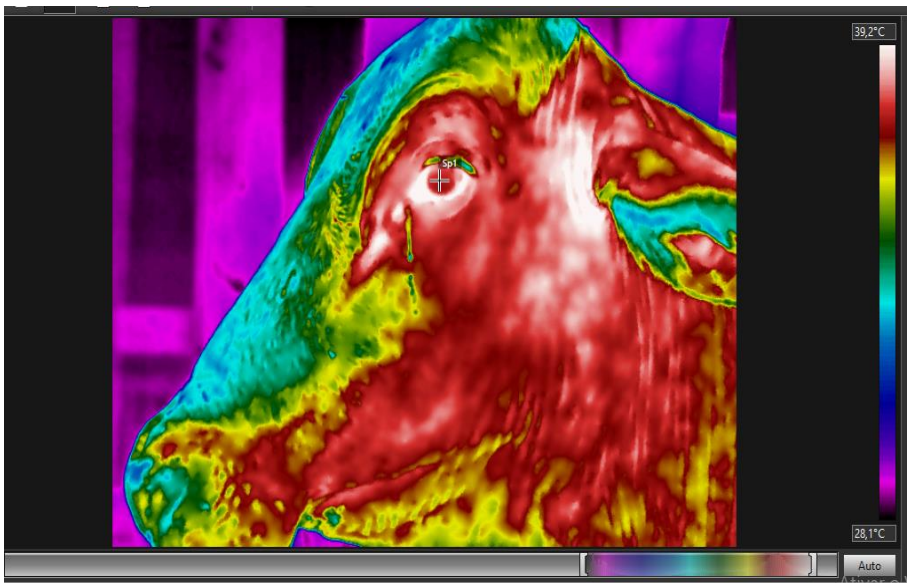
The non-invasive thermographic technique avoids stress to the animal, favoring its well-being (Alejandro et al., 2014, Metzner et al., 2014, Talukder et al., 2015, Chacur et al., 2016), in addition, can be used in the thermal diagnosis of different processes, including the indication of pathological changes and inflammatory processes (Leão et al., 2015; Silva et al., 2019). Thus, the objective of this work was to perform the thermographic evaluation of the mammary glands and the eyeball of dairy cattle females on a rural property in the municipality of Mojuí dos Campos, in Western Pará.

2. Material and Methods

The study was carried out on a rural property located in Western Pará, in the municipality of Mojuí dos Campos (03 ° 04'13.58 "S and 54 ° 34'30.54" W). The mammary glands and eyeball of eight (n = 8) dairy cattle females were separated into two (2) experimental groups: Lactating (LACT, n = 4) and Non-Lactating (N-LACT, n = 4). All females were pluriparous of the Girolando breed, maintained in a semi-intensive system, with an average age and weight of 7 years and 450 kg, respectively. The animals' diet was based on roughage (*Brachiaria brizanta* and *Panicum maximum* cv. Mombaça) and protein supplementation (Salrama). In addition, females had access to mineral salt and water ad libitum, and the average daily milk production was 12 liters.

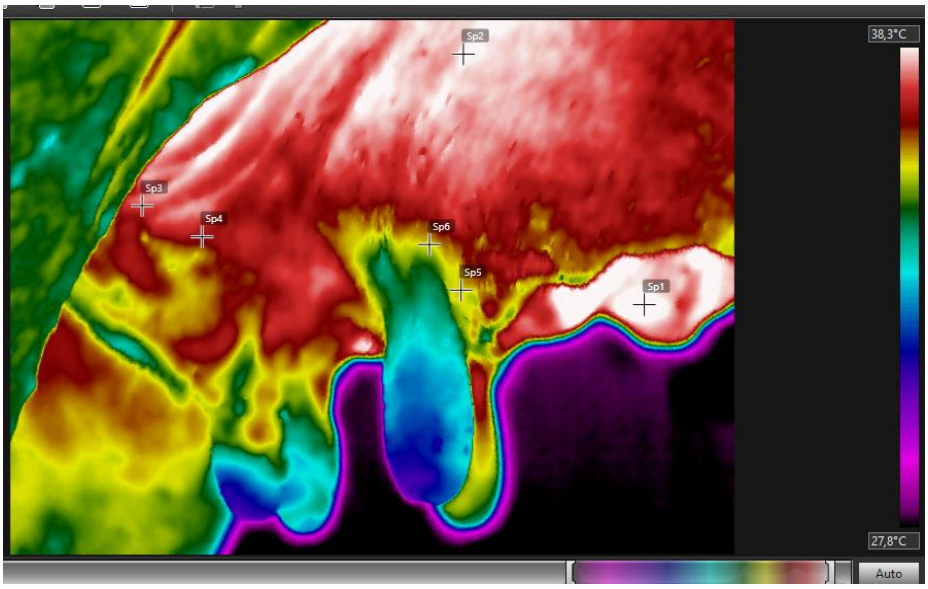
To assess the surface temperature of the mammary glands (upper, middle and final third) (Figure 1) and the eyeball (medial region) (Figure 2), an infrared thermograph (FLIR T650sc, Wilsonville, OR, USA) was used.

Figure 1. Temperature of the eyeball.



Source: Authors (2020).

Figure 2. Thermographic image of the mammary gland, with 2 targets imaged by pattern color, showing different temperatures.



Source: Authors (2020).

In each evaluated region, two representative samples were taken by color pattern, that is, white, which corresponds to the upper third, red to the medial third, and yellow to the final third of the mammary gland.

Considering that the climatic conditions must be evaluated among the factors that determine the milk production and that the crosses aim to reconcile the high productivity of the Taurine breeds with the rusticity (adaptability to hot climate) of the Zebu breeds, air temperature data were analyzed made available by the National Meteorological Institute (INMET) of a meteorological station installed in the municipality of Belterra.

For the statistical analysis, the program Past version 2.16 was used, verifying the mean, standard deviation and variance, as well as the analysis of variance with the Anova One-WayeTukey test (5%).

3. Results and Discussion

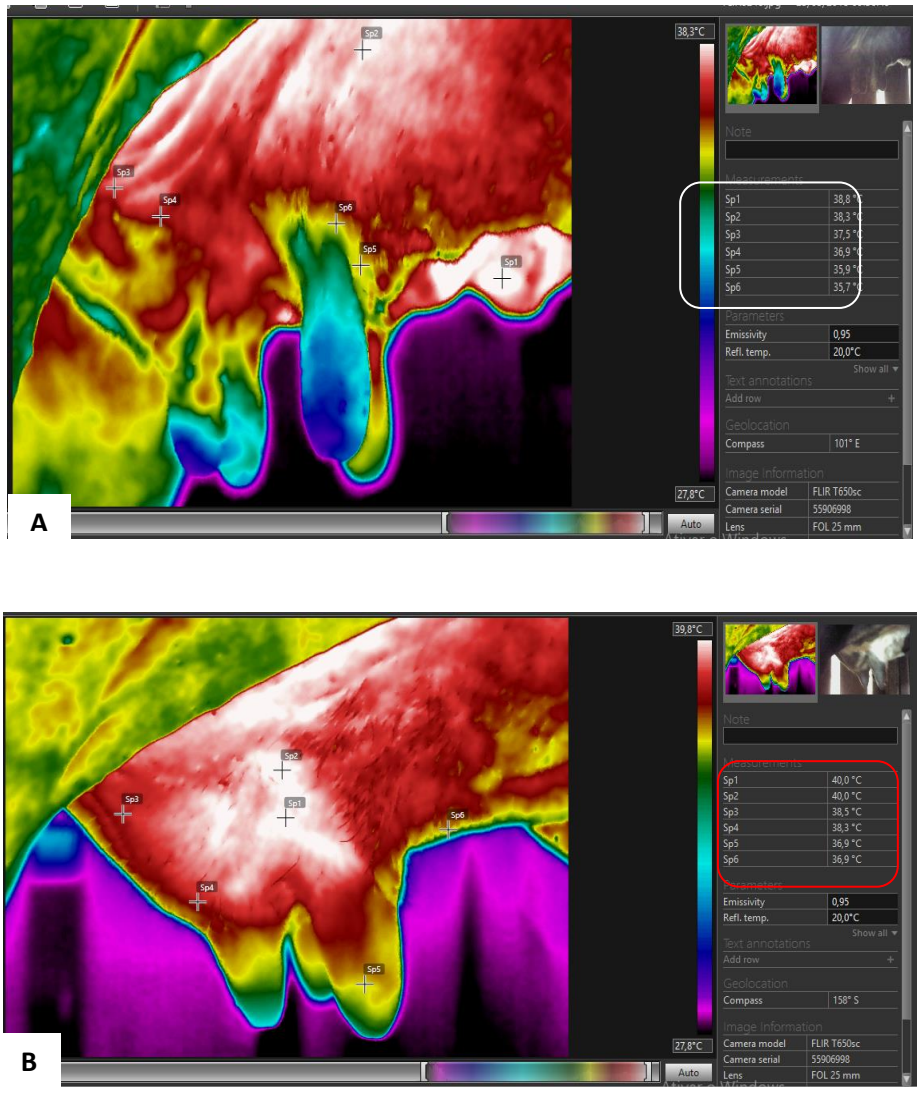
Comparing the LACT and N-LACT groups, no significant difference was detected between them ($P \geq 0.05$), this fact is probably related to the correct handling and the good breeding conditions to which the females were submitted, which can have avoided physiological changes, such as elevated surface temperature even in lactating females.

In the LACT group, mean values of 40.2°C ± 0.8, 38.9°C ± 0.6 and 37.5°C ± 0.6 and N-LACT of 39.6°C ± 0 were found, 9, 38.0°C ± 0.7 and 36.8°C ± 0.7, respectively. Thus, it was observed that infrared thermography was efficient in the evaluation of the females, indicating that they were in environmental thermal comfort.

In this study it was possible to identify that the average temperature of the final third and the upper third was 37.5°C and 40.2°C, respectively. Thus, when comparing these results with those described by Chacur et al. (2016b) in buffalo calves, heifers, pregnant women and lactating mothers, a lower average temperature was observed in the different categories, being 21.6°C in the final third (ceiling) and 37.6°C in the upper third (cistern), with difference of 15.9ºC and 2.6ºC, respectively, which may be indicative of thermal stress or subclinical mastitis. Polat et al. (2010) describe that breast quarters with subclinical mastitis can show up to 2.35ºC differences for healthy cows. However, Bortolami et al. (2015) found animals with subclinical mastitis with temperatures lower than those reported by Polat et al. (2010). It is worth mentioning that Chacur et al. (2016b) studied buffalo females, which have greater rusticity and a better adaptive response to adverse climatic conditions, including hot climates (Malhado, 2007, Marai and Habeeb, 2010).

The temperatures observed in the present study were higher when compared to the data obtained by Chacur et al. (2016a) in lactating cows and negative to the California Mastitis Test (CMT), pregnant and non-pregnant, with a surface temperature ranging from 30.5ºC to 36.8 ° C in the upper third, from 29.7ºC to 36.9ºC in the medium and from 27.9ºC to 35.9ºC at the end. The factor that may be related to this result is the high relative humidity of the air (94%) observed on the day of the capture of the thermographic images, which significantly contributes to the retention of heat due to the difficulty in the process of eliminating it to the environment. Metzner et al. (2014) affirm that there is a direct interference of the relative humidity of the air and ambient temperature in the increase of the body temperature of the animals, being possible to attribute the possible responses expressed in the thermograms of the mammary glands (Figure 3- A and B) to the local climatic conditions in the present study.

Figure 3. Treated images of the mammary gland, showing the points imaged in non-lactating (A) and lactating cows (B).



Source: Authors (2020).

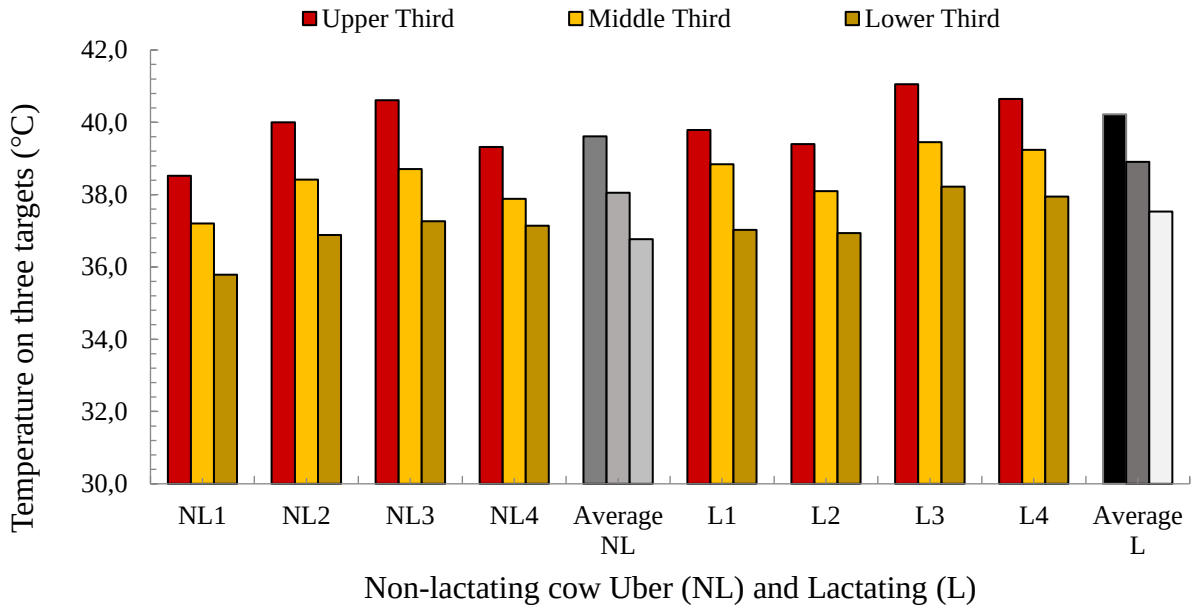
It is noteworthy that in the period of capture of the thermographic images, the air temperature had an average value of 22.9°C and the relative humidity of 94%. Detecting maximum temperature of 27.1°C, average of 24.0°C and minimum of 22.7°C. Reinforcing that the environmental thermal conditions were attenuated by the cloudiness due to the high rainfall (132.4 mm) also observed.

Nogueira et al. (2015) observed in the mammary gland of dairy cows a surface temperature without inflammatory changes of 38.2 ° C, with clinical mastitis of 39.3ºC and with subclinical mastitis of 37.3ºC. Diverging from the study by Santos et al. (2019) who showed that the surface temperature of healthy animals (29.3ºC and 32.2ºC) was lower than that of animals with subclinical mastitis (33.2ºC and 34.6ºC) and clinical (34.0ºC and 37.5°C).

According to Hovinen et al. (2008) there is an increase of 1ºC and 1.5ºC in the surface temperature of the mammary gland, when comparing dairy cows with clinical and healthy mastitis.

In the present study, a reduction in surface temperature was observed in both groups as the final third of the mammary gland occurs (Figure 4), probably attributed to the physiological condition itself, that is, because it is the area with the lowest blood flow in women. mammary glands, in addition to the possibility of greater heat loss.

Figure 4. Surface temperature in the regions of the upper third (Sp1 and Sp2), middle third (Sp3 and Sp4) and final third (Sp5 and Sp6) of the mammary gland.

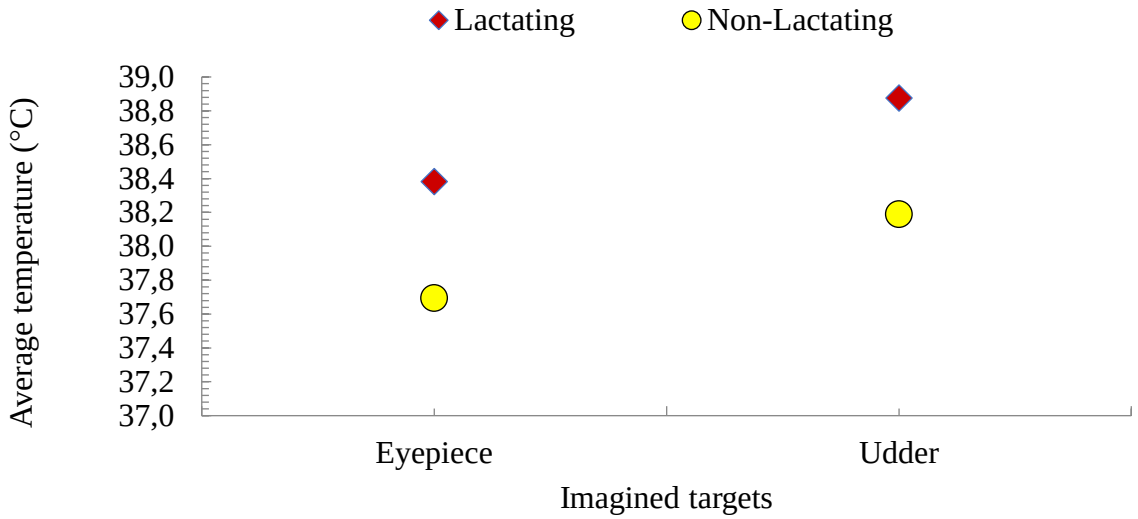


Source: Authors (2020).

Regarding the surface temperature of the eyeball, there was no statistical difference between the LACT and N-LACT groups (P≥0.05), with an average of 37.3ºC ± 0.8 and 36.3ºC ± 0.8, respectively (Figure 5). Such temperature can be used as a body temperature parameter, as according to Schmidt et al. (2013), eye temperature has a high correlation with body temperature, as the eyeball is close to the brain, thus, it becomes a reliable point for measuring body temperature. Thus, when comparing the groups, there was an increase, even if not significant, of 1 ° C in LACT females when compared to the N-LACT group, suggesting a higher body temperature, which is probably related to the increase in metabolism in the period lactation. According to Gonçalves (2013) and Nikkhah (2015) body temperature is strongly

influenced by the physiological changes that occur in the tissues, in addition to the interference of external factors such as the relative humidity of the air and the ambient temperature.

Figure 5. Eye temperature of lactating and non-lactating cows.



Source: Authors (2020).

4. Conclusion

Based on this information it was possible to observe that the infrared thermography detected that the evaluated females were in adequate conditions of environmental thermal comfort and the physiological changes resulting from lactation were not able to cause an increase in the surface temperature of the mammary glands and the eyeball. These results are probably related to the correct handling and the good breeding conditions to which the bovine females were submitted. Therefore, infrared thermography can be used in dairy herds, as it proved to be efficient in the evaluation of lactating and non-lactating females. However, it is emphasized that further studies must be carried out.

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