Arq. Bras. Med. Vet. Zootec., **v.78, n.3, e13570, 2026**
http://dx.doi.org/10.1590/1678-4162-13570
Case Report - Veterinary Medicine

Infrared thermography as a non-invasive tool for pregnancy diagnosis and abortion detection in cows – case report

[*Termografia infravermelha como ferramenta não invasiva para diagnóstico de gestação e detecção de aborto em vacas – relato de caso*]

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ABSTRACT

Detecting and monitoring pregnancy in cattle is essential and can be achieved through various methods. In recent years, new technologies have been explored to better understand reproductive phenomena, with particular attention given to non-invasive approaches. This study reports thermographic and clinical findings of two Zebu cows (Cow 1: spontaneous abortion; and Cow 2: pregnant) at 236 days of gestation. Eight hours after abortion, thermal imaging and rectal temperature were recorded (First Trial) and compared with the pregnant cow, kept under the same housing and dietary conditions. A second evaluation was conducted five days later (Second Trial). No clinical abnormalities or fever were observed in either cow. In both trials, the pregnant cow consistently showed a 0.9°C higher average abdominal temperature compared with the cow that experienced spontaneous abortion. This difference may be related to increased blood flow and metabolic activity in the uterus during gestation, resulting in greater heat conduction to the body surface. Despite the short interval post-abortion, thermography detected temperature differences suggestive of reproductive status. These findings support the potential of infrared thermography as a non-invasive tool for assessing reproductive status and thermal physiology in cattle.

Keywords: gestation, pregnant cow, reproduction, spontaneous abortion, thermal camera.

RESUMO

A detecção e o monitoramento da prenhez em bovinos são essenciais e podem ser realizados por diferentes métodos. Nos últimos anos, novas tecnologias têm sido exploradas para ampliar a compreensão dos fenômenos reprodutivos, com destaque para abordagens não invasivas. Este estudo apresenta achados termográficos e clínicos de duas vacas Zebu (vaca 1: aborto espontâneo; vaca 2: prenhe), aos 236 dias de gestação. Oito horas após o aborto, foram registradas imagens térmicas e temperatura retal da vaca que teve aborto espontâneo, sendo os dados comparados aos da vaca prenhe (primeira avaliação), ambas mantidas sob as mesmas condições de manejo, alojamento e alimentação. Cinco dias depois, uma segunda mensuração foi realizada (segunda avaliação). Nenhuma anormalidade clínica ou febre foi observada em nenhuma das vacas. Em ambas as avaliações, a vaca prenhe apresentou, de forma consistente, temperatura abdominal média 0,9°C mais elevada em comparação à vaca que abortou. Essa diferença pode estar relacionada ao aumento do fluxo sanguíneo e da atividade metabólica no útero durante a gestação, o que resulta em maior condução de calor para a superfície corporal. Apesar do curto intervalo após o aborto, a termografia foi capaz de detectar diferenças de temperatura compatíveis com o estado fisiológico dos animais. Esses resultados reforçam o potencial da

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Submitted: April 28, 2025. Accepted: October 21, 2025.

termografia infravermelha como ferramenta não invasiva para avaliar o estado reprodutivo e a fisiologia térmica em bovinos.

Palavras-chave: aborto espontâneo, câmera térmica, gestação, reprodução, vaca prenhe

INTRODUCTION

In cattle, gestation can range between 279 and 285 days, depending on maternal and fetal factors (Toniolo and Vicente, 2003). Pregnancy loss is a significant concern in dairy herd, since milk production is dependent on conception, gestation, and parturition of cows. While early embryonic mortality is relatively common, late-term pregnancy losses, including abortion in the final trimester, have severe consequences for herd management and productivity (Abdalla *et al*., 2017). Thus, regular pregnancy checks allow early identification of reproductive failures, enabling timely interventions and better resource allocation.

The detection and monitoring of pregnancy in cattle rely on various methods, including transrectal ultrasound, progesterone trials, and transrectal palpation (Speckhart *et al*., 2018). However, more recently other technological tools may assist in reproductive monitoring. Infrared thermography (IRED) is one of those diagnostic methods, which has previously been explored to evaluate pregnancy status of different species, such zebras, rhinoceros, giraffes (Hilsberg *et al*., 1997), pandas (Durrant *et al*., 2006), cattle (Montanholi *et al*., 2015; Olğaç *et al*., 2023), horses (Bowers *et al*., 2009; Domino *et al*., 2022) and pigs (Gulliksen *et al*., 2023).). IRED detects temperature variations on the animal's body surface, making it a valuable tool for identifying biological events associated with thermal changes (Melo *et al*., 2022). One of its key advantages is that it can be used from a distance, reducing the need for direct physical interaction with the animal. Thus, minimizes stress and enhances both animal welfare and handler safety during assessments (Stewart *et al*., 2007).

Despite being a promising technique, there is a lack of studies on the use of IRED in cattle herds, especially zebu breeds. This case describes the potential use of an infrared thermography camera as tool for pregnancy and abortion detection in Gyr cows.

ETHICAL ASPECTS

This case report describes a clinical procedure performed exclusively for therapeutic purposes, in accordance with current ethical principles and animal welfare standards. Therefore, submission to the Ethics Committee on Animal Use was not required.

CASUISTRY

Two pregnant nulliparous dairy Gyr cows (*Bos taurus indicus*) were housed in a collective feedlot pen and fed a mixed diet of corn and wheat silage with *ad libitum* access to water at the Campo Experimental Getúlio Vargas of Empresa de Pesquisa Agropecuária de Minas Gerais (Uberaba, Minas Gerais, Brazil). All animals were inseminated on the same day via fixed-time artificial insemination (FTAI). At 236º day of gestation, one cow (Cow 1: 471kg; 37 months of age) had spontaneous abortion around 5:00 AM, as later confirmed by video recordings. Eight hours after the abortion, the cow was restrained in a handling chute for examination and clinical assessment (First Trial). Before the physical exam, a thermal imaging camera (FLIR T530, FLIR Systems, Inc., Oregon, USA) was used to assess temperature in the right abdominal region. A standard distance of 120 cm between the animal and the camera was maintained. Emissivity was adjusted (0.98 ε) and the camera resolution was calibrated according to local ambient temperature and humidity, following manufacturer recommendation prior to the start of imaging capturing. Additionally, rectal temperature was measured with a digital thermometer (precision of ±0.1◦C, T-DIV-0132, Incoterm®, Porto Alegre, Brazil). During clinical examinations, rectal palpation and ultrasound confirmed the abortion, but no additional reproductive complications (*e.g.* retained placenta) or fever were detected. Further physical examination revealed no signs of distress, prostration, or pain, only mucoid vulvar discharge. The exact cause of the abortion remained undetermined, and no fetus' necropsy was performed. The herd tested negative for brucellosis and tuberculosis; however, no additional tests were performed to identify the causative agent. A prophylactic treatment protocol (oxytetracycline: 1ml/Kg IM, once daily for three consecutive days; estradiol cypionate: 5ml/animal IM, single administration) was administered. For comparative purposes, immediately after examining Cow 1, thermographic imaging was also performed on another pregnant nulliparous cow (Cow 2: 236 days of gestation; 497kg; 37 months of age) kept under the same dietary, management and house conditions. In both images collection, the FLIR Tools Software (FLIR Systems, Inc., Oregon, USA) was used to trace an elliptical region on the abdominal area, and calculate maximum (max.), average (avg.), and minimum (min.) temperatures, adapted from Vicentini *et al*. (2020). Thermal images were recorded and analyzed using the 'rainbow' palette (Fig. 1: A and B) which lighter colors (white) indicate warmer areas and where darker colors (blue) indicate cooler areas. Subsequently, the 'alarm' palette was applied to the same images to enhance visualization of temperature distribution, highlighting areas ≥35.0ºC in red and <35,0ºC in black/white (Fig. 1: C and D). Based on the traced region the values for temperatures for Cow 1 and Cow 2 were recorded (Fig. 1).

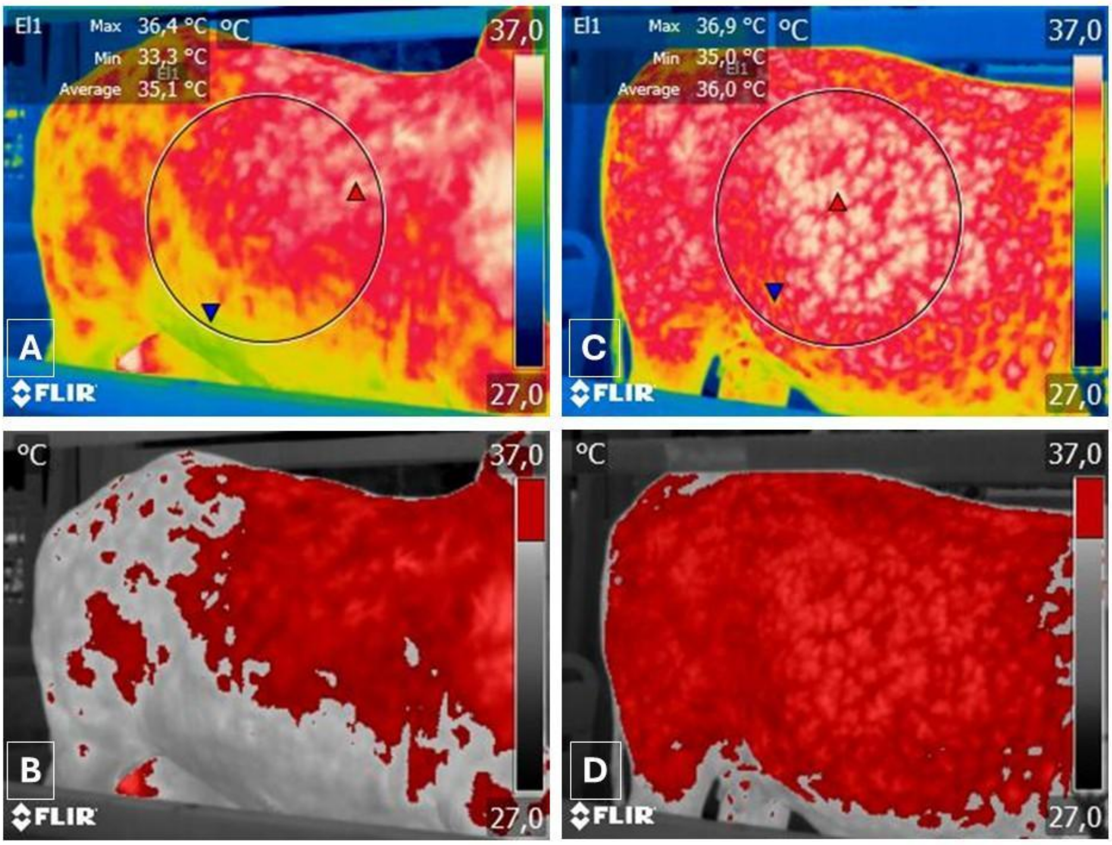

Figure 1. Thermographic images and traced abdominal region for temperature in Gyr cows on First Trial. A: Cow 1 (non-pregnant) in 'rainbow' palette; B: Cow 1 (non-pregnant) in 'alarm' palette; C: Cow 2 (236 days of gestation) in 'rainbow' palette; D: Cow 2 (236 days of gestation) in 'alarm' palette. 'rainbow' palette (A and C): lighter colors (white) indicate warmer areas where darker colors (blue) indicate cooler areas. 'alarm' palette (B and D) indicates areas ≥35.0ºC in red and areas <35.0ºC in black/white.

Five days later, the handling procedure was repeated as previously described, with the animals being guided into the handling chute and properly restrained (Second Trial). Thermographic imaging and rectal temperature measurement were conducted under the same conditions and concluding with a transrectal ultrasound examination. No abnormalities or signs of fever were detected in either animal during clinical assessments. Additionally, thermogram analysis of the right abdominal region was performed for both Cow 1 and Cow 2, as presented in Fig. 2.

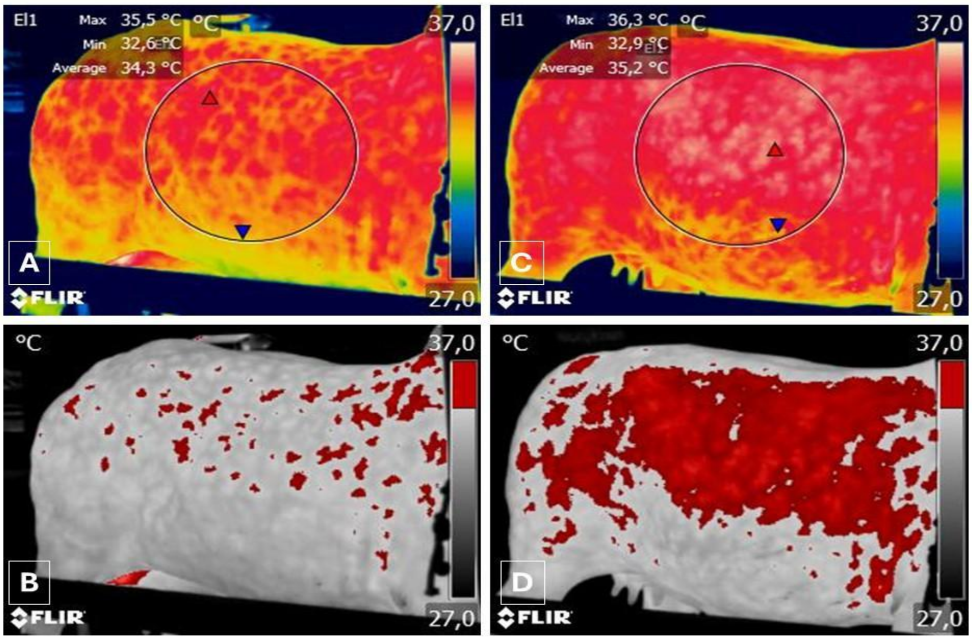

Figure 2. Thermographic images and traced abdominal region for temperature in Gyr cows on Second Trial. A: Cow 1 (non-pregnant) in 'rainbow' palette; B: Cow 1 (non-pregnant) in 'alarm' palette; C: Cow 2 (241 days of gestation) in 'rainbow' palette; D: Cow 2 (241 days of gestation) in 'alarm' palette. 'rainbow' palette (A and C): lighter colors (white) indicate warmer areas where darker colors (blue) indicate cooler areas. 'alarm' palette (B and D) indicates areas ≥35.0ºC in red and areas <35.0ºC in black/white.

Uterine cytology was not performed on Second Trial to rule out subclinical endometritis because the inflammatory process is low-grade, characterized by immune cell infiltration without intense activation of vasodilatory mediators that would lead to increased blood flow. Visual observations in the following days of Second Trial revealed no signs of abnormal behavior (*e.g.* apathy, anorexia or lethargy) or apparent clinical complications in the cows. Table 1 compiles body temperature data from non-pregnant and pregnant cows collected in both trials.

Table 1. Body temperature of non-pregnant and pregnant cows measured with a digital thermometer[1] and infrared thermography[2] across two trials

Animals	Rectal Temperature[1]	Abdominal region temperature[2]		
		Max.	Min.	Avg.
		First Trial		
Cow 1 (non-pregnant)	39.1	36.4	33.3	35.1
Cow 2 (236 days of gestation)	38.8	36.9	35.0	36.0
		Second Trial		
Cow 1 (non-pregnant)	38.6	35.5	32.6	34.3
Cow 2 (241 days of gestation)	38.7	36.3	32.9	35.2

Max.: maximum; Avg: average. Min: minimum.

DISCUSSION

Pregnancy induces several physiological and anatomical changes in the female body, particularly in the reproductive and circulatory systems. As gestation progresses, increased blood flow to the uterus and surrounding tissues supports fetal development and placenta function, leading to localized temperature variations (Reynolds *et al*., 1986; Baumgard and Rhoads, 2013). Additionally, hormones play important role not only in fetal maintenance and communication but also is known that progesterone which maintains pregnancy has a thermogenic effect to increase female body core temperature (Wrenn *et al*., 1958; Aoki *et al*., 2005).

The observed temperature increase in the pregnant cow (Cow 2) aligns with these physiological changes, as elevated blood perfusion and tissue metabolism generate more heat in the uterus and surrounding structures. Montanholi *et al*. (2015) demonstrated in their study a pregnant cow with higher temperature values in abdominal regions. Bowers *et al*. (2009) and Domino *et al*. (2022) also reported that mares had higher temperatures in the flank region in late gestation phase compared with non-pregnant mares. During this phase, intrauterine tissue proliferates, and uterine blood flow increases (Reynolds *et al*., 1986; Domino *et al*., 2022). Thus, these physiological changes result in body surface temperature changes near the womb (Bowers *et al*., 2009). In the First trial, for Cow 1 (non-pregnant), the average temperature was 0,9°C lower compared to Cow 2 (pregnant). Even though eight hours after fetus abortion are not timely enough to total physiological recovery, the range was highlighted. Interestingly, in the second trial, the difference in average temperature between the cows was also 0.9°C. These findings suggest compatible physiological conditions, with temperature variations consistent with previous assessments. This temperature discrepancy may be attributed to heat being conducted through the tissue layers toward the body surface of the pregnant cow, creating a relatively warmer area that can be detected in the abdomen compared with the non-pregnant cow. As pregnancy progresses, the uterus gradually shifts toward the caudoventral abdominal right side, while the left cavity remains primarily occupied by the rumen (Buczinski *et al*., 2011). Thus, the presence of fetus on lower abdominal region may cause more pressure aligned with substantial metabolic output, producing enough heat to form thermal print. Another important factor to consider is that neither cow showed signs of fever, as indicated by their rectal temperatures. In dairy cattle, fever thresholds typically range from 39.4 to 39.7°C (revised by Galán *et al*., 2018), while normal rectal temperatures for Gyr cattle are reported to range from 36.7 to 39.1°C (Cardoso *et al*., 2015). Thus, these findings strongly suggest that pregnancy itself was the main factor contributing to the higher flank temperature observed in the pregnant cow compared to the non-pregnant one.

Zebu cattle exhibit distinct behavioral and physiological traits compared to taurine breeds (*Bos taurus taurus*). These differences may extend to thermal physiology, particularly during reproductive events. In a study on the estrus cycle of Gyr cows, Vicentini *et al*. (2020) demonstrated that this breed has higher body temperatures than European breeds, likely due to their adaptation to tropical climates. Curiously, regarding pregnancy, Vicentini *et al*. (2021) described body temperature patterns fluctuations in Gyr cows close to calving with a smaller magnitude than that previously described for taurine cattle. This implies that thermal responses during late gestation may vary between genetic groups, potentially reflecting differences in metabolic adaptation and environmental resilience. However, our findings suggest that even with these differences, the IRED technology is capable to identify pregnancy in late gestation in Gyr breed.

Early and accurate pregnancy diagnosis is essential for reproductive management, optimizing breeding programs, and reducing economic losses. Traditional methods such as rectal palpation and ultrasound remain effective, but they require skilled personnel and direct handling —often invasive— of the animals, which can cause stress (Fricke *et al.*, 2020). Therefore, thermographic imaging offers an alternative by allowing remote monitoring, potentially minimizing the need for frequent physical examinations. In addition to detecting pregnancy, this method in the future could also help identify gestational complications, such as abnormal temperature patterns linked to fetal distress or early pregnancy loss.

CONCLUSION

Infrared thermography was effective in recording body temperature variation as tool for pregnancy diagnosis and abortion detection in cows. This is the first record in literature to use Infrared thermography as this non-invasive diagnosis method in Zebu breed. Further research will enable us to describe and determine the baselines and patterns of body temperature of Zebu cattle in different phases of gestation, to elucidate issues regarding body temperature variation and thermal physiology related to health and reproduction traits.

ACKNOWLEDGEMENTS

The authors thank Campo Experimental Getulio Vargas (CEGT - EPAMIG Oeste) for kindly providing the animals and infrastructure necessary for the study, and the students and staff who collaborated with the study. We also acknowledge Instituto Nacional de Ciências e Tecnologia em Ciência Animal (INCT-CA) and Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG) for financial support.

CONTRIBUTORS

R.R. Vicentini: study conception, methodology, formal analysis, supervision, project administration, manuscript writing, review, and editing; R.C. Castanheira: methodology; A.V.R. Silva: methodology and manuscript writing, review, and editing; G.H.B. Silva: methodology; I.C. Ferreira: manuscript writing, review, and editing; E.A. Silva: manuscript review and editing, project administration and funding acquisition; L.E.F. Zadra: manuscript writing, review and editing; F.O. Franco: funding acquisition and manuscript review.

DATA AVAILABILITY STATEMENT

The research data are available within the article itself.

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