DETECTION OF LAMENESS IN DAIRY COWS USING INFRARED THERMOGRAPHY*

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Review paper

Abstract

Lameness in dairy cows is one of the bigest problems in dairy farming. Lameness compling with pain and discomfor of the animals witcht disrupt the welfare. Besides that, requires medical care and additional costs resulting in large economic losses. Early detection of hoof inflammation in animals is important to prevent lameness. Infrared thermography (IRT) is a non-contact method for recording the temperature on the body surface of animals or other objects. IRT has great potential as an automated diagnostic method for lameness in dairy cows. Each method has its advantages and disadvantages, including IRT, so all positive and negative influences should be taken into account before making a final conclusion. Due to the great influence of the environment and the animal current biological status, it is crusual to ensure adequate conditions at the location of the recording and to consider the influence of the animal itself. It is necessary to have additional support from other lameness detection techniques and data sets that will complement the application of IRT, such as visual hoof observation and behavioural observation methods for dairy cows.

Keywords: *lameness, detection, infrared thermography, dairy cows, risk factors*

INTRODUCTION

The lameness in lactating cows is one of the major problems in intensive milk production (Whay *et al*., 2003). Lameness caused by various hooves diseases affects animal welfare, leads to reduced milk production, increases feeding costs and causes huge economic losses (Green *et al*., 2002; Ózsvári, 2017). According to different authors, the average lameness rate of cows ranged between 18 to 37% in Europa (Griffiths *et al*., 2018; Sjöström *et al*., 2018). Cha *et al.* (2010) have established the average cost per cow from 120.70 to 216.07 US dollars depending on the type of the hoof's diseases (sole ulcer, digital dermatitis, foot rot) and according to various costs of lameness (milk loss, decreased fertility, treatment costs). Because of that is crucial to prevent the incidence of lameness and detect those animals which are in the initial phases of illnesses. Those cows are not yet have walking problem, not yet experienced

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the pain or discomfort. Detection of cows in that stage is possible using newer technologies such as infrared thermography. Automated lameness detection systems are very useful, as farmers do not have to spend time watching cows walk. For that purpose can be used a pressure platforms that can measure the cows pressure (separately for each hoof) when the cow walks or stands (Pastell *et al*., 2010; Maertens *et al*., 2011). In addition, there are systems that allow automatic tracking the changes in feeding behavior and activity associated with lameness (Blackie *et al*., 2011; Beer *et al*., 2016). According to previous research, it was observed the necessity of using multiple monitoring systems, i.e. different sensors, in order to increase accuracy of problem detection (Borchers *et al.*, 2017). Many automated lameness detection technologies have been proposed to assist dairy farmers in managing their herds. However, reasons such as cost and skepticism among farmers themselves, who do not see the usefulness of these new technologies for application on their farms, are limiting factors for the greater application of such innovative systems on farms (Dutton-Regester *et al.*, 2020). Dutton-Regester *et al.* (2020) also points out that is a need to more thoroughly evaluate the effectiveness of these technologies under on-farm conditions in order to generate the necessary data required to show dairy farmers that these technologies are reliable and are economically rational for their dairy business.

ADVANTAGES OF INFRARED THERMOGRAPHY

Infrared thermography (IRT) is a contactless method that measures emitted infrared radiation of the surface temperature of an object (Alsaod *et al.*, 2015). Lin *et al.* (2018) states that IRT is such tip diagnostic tool which can detect mininor changes in skin temperature without tachung the animals. Which can indirectly measures blood flow changes associated with inflammation from foot lesions. This method has been widely used in industry, veterinary medicine and in livestock production (Hurnik *et al.*, 1985; Harper, 2000; Eddy *et al*., 2001). Furthermore, according to Alsaaod and Büscher (2012) and Bobić *et al.* (2017) this method could be used as tool for the prevention of lameness in dairy production. That support also Schaefer and Cook (2013), who emphasizes that there are compelling thermal signatures that can be identified in the image when lameness occurs due to inflammation. It is known that during inflammation, vascular circulation increases, which consequently leads to increased blood flow to the inflamed area, thereby changing the temperature of the inflamed part of the body. The temperature of extremities and skin is largely dependent on the underlying circulation and tissue metabolism rate. Inflammation or metabolic activity can be associated with changes in blood flow which lead to changes in the amount of heat radiated and consequently with surface thermal patterns, which can be easily identified using infrared thermography (Bobić *et al.,* 2024). Nikkhah *et al.* (2005) concluded that IRT could detect inflammation due to laminitis in cows during early and midl lactation. In the research of the Alsaood *et al.* (2014) was condacted a threshold value of 0.99 °C in maximum coronary band temperature difference between hind and front feet for detection of dermatitis digitalis. According to Harris-Bridge *et al.* (2018) the maximum temperature measured at the heels had the highest accuracy in detecting and predicting of lameness despite of the risk of contamination through dirt and faeces in housed dairy cattle. Furthermore, the opposite opinion was held by Marti *et al.* (2015) who consider that infrared thermography was not a useful tool for differentiating of the claw area temperatures between beef feedlot cattle diagnosed with foot rot and digital dermatitis. Another study that also gave a positive opinion about thermal imaging is a study from LokeshBabu *et al.* (2018) whitch emphasises that the infrared thermography is a method with high rate of success methods for early detection of lesions before the occurrence of visibly symptoms. And they also add that infrared thermography have good results especially in combination with other diagnostic tools.

DISADVANTAGES OF INFRARED THERMOGRAPHY

Each diagnostic method has its advantages but unfortunately also certain disadvantages. One of the main disadvantages of infrared thermography is the susceptibility to environmental conditions. The accuracy and the interpretation of thermograms of thermal imaging is determined by many things, such as: ambient temperature, current environmental conditions, solar radiation, airflow, the size of the scanned object and background radiation, angle and distance (Alsaaod and Büscher, 2012; Westermann *et al.,* 2013; McManus *et al.,* 2022). Besides that, the influence of the animal itself is great, because of the different blood circulation and body status of ich animal can influence the thermal radiation thus complicating the interpretation of thermograms (Alsaaod *et al.,* 2015). Body temperature varies throughout the day and depends on different activities of the animal (physical activity, food intake, time of day etc. (Novotna *et al*., 2019; Moreira *et al.,* 2021). In addition to the influence of animals, environmental factors also affect the appearance of the thermogram, for exemple by dirt that covers the animal, which impairs the normal emissions of infrared radiation from the body surface. Montanholi *et al.* (2015) state that image quality can be affected by the distance from which it is captured. The choice and quality of thermocamera is very important, because the infrared thermography sometimes gives false positive results and can lead to wrong conclusions (Novotna *et al.,* 2019). High-quality thermocameras are expensive, but cheaper models are available on market have lower image quality and resolution (Lokesh-Babu *et al.,* 2018). Therefore, it is necessary to select suitable equipment for thermographic measurements (Montanholi *et al.,* 2015; Werema *et al*., 2023), and take into account all the possible negative influences that can lead to an incorrect reading of the thermogram.

CONCLUSIONS

Infrared thermography has great potential as an automated diagnostic method for lameness in dairy cows. Due to the great influence of the environment and the animal itself, it is crucial to ensure adequate conditions at the location of the recording and to consider the influence of the animal itself and its current biological status. It is necessary to have additional support from other lameness detection techniques and data sets that will complement the application of IRT.

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OTKRIVANJE ŠEPAVOSTI KOD MUZNIH KRAVA PRIMJENOM INFRACRVENE TERMOGRAFIJE

Sažetak

Šepavost mliječnih krava jedan je od najvećih problema na farmama za proizvodnju mlijeka. Šepavost uz bol i nelagodu životinja narušava dobrobit. Osim toga, zahtijeva medicinsku skrb i dodatne troškove koji rezultiraju velikim ekonomskim gubicima. Rano otkrivanje upale papaka kod životinja važno je za sprječavanje šepavosti. Infracrvena termografija (IRT) je beskontaktna metoda za bilježenje temperature na površini tijela životinja ili drugih predmeta. IRT ima veliki potencijal kao automatizirana dijagnostička metoda za šepavost kod mliječnih krava. Svaka metoda ima svoje prednosti i nedostatke, pa tako i IRT, pa prije donošenja konačnog zaključka treba uzeti u obzir sve pozitivne i negativne utjecaje. Zbog velikog utjecaja okoliša i trenutnog biološkog statusa životinje, ključno je osigurati odgovarajuće uvjete na mjestu snimanja te uzeti u obzir utjecaj same životinje. Neophodno je imati dodatnu podršku drugih tehnika za otkrivanje šepavosti i skupova podataka koji će nadopuniti primjenu IRT-a, kao što su vizualno promatranje papaka i metode promatranja ponašanja mliječnih krava.

Ključne riječi: *šepavost, otkrivanje, infracrvena termografija, mliječne krave, čimbenici rizika*