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The effects of parity and stage of lactation on hoof temperature of dairy cows using a thermovision camera

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Abstract

The aim of the study was to determine the effects of the parity and stage of lactation on tissue changes of the dairy cows' hooves (Holstein; n = 130) and their early detection using the thermovision camera. The parity did not have a significant impact on temperature of the coronary band (CB) for the cows with lesions, although the stage of lactation did ($P<0.0001$) between first and second parity. For the cows without lesions the parity and stage of lactation had a significant ($P<0.01$; $P<0.0001$) influence on the temperature of the CB. The obtained results indicate that stage of lactation has a stronger influence on temperature of coronary band than parity. This knowledge is crucial when using thermovision cameras for detection of the cows which are at risk of lameness.

Keywords: dairy cows, detection, hoof diseases, parity, stage of the lactation, thermovision camera

Introduction

According to Whay et al. (2003) the diseases of the hoofs and the incidence of lameness in lactating cows is one of the major problems in intensive milk production. These diseases disrupt the welfare of animals, induce drop in milk production and finally increase the cost of breeding, resulting in large economic losses (Green et al., 2002), varying between € 40-50 per cow and € 100-300 per case (Ózsvári, 2017). Severe previous studies stated that incidence of lameness depending of production level, parity and stage of lactation (Warnick et al., 2001; Kocak and Ekiz, 2006; Olechnowicz and Jaśkowski, 2010; Solano et al., 2015; Sadiq et al., 2017). Infrared thermography is a good method for the visualization and determination of the differences in the surface temperature of the measured body or object (Alsaaod and Büscher, 2012). 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, in dairy production this method could be used as tool for the prevention of lameness (Alsaaod and Büscher, 2012; Bobić et al., 2017b). The aim of the study was to determine the effects of the parity and stage of lactation on tissue changes of the dairy cows' hooves and their early detection using the thermovision camera.

Materials and methods

The study was conducted on Holstein cows (n=130) that were in 1st to 6th parity and lactation stage from 10–400 days. The cows were housed in modern dairy farms (deep bedding and cubicle beds). In the treatment area, after milking, the measurement of the surface temperature of hoofs (coronary band, CB) were conducted by a thermovision camera – TC (Flir and 7, FLIR Systems, Inc., Boston, USA) with 0.95 emissivity. Before measurements the floors and legs of all cows were cleaned of impurities. Measurements (shooting) were performed from a distance of 1 meter from the front side of the animal's leg. The ambient temperature during the shooting was between 19–21 °C. All the time, the one person was examine animals with TC (all four hoofs), and all the animals that were examined did not have any visually noticeable changes in the movement (lameness) or on the hoofs. When the high temperature reading of the camera appeared (Figure 1), the cow was separated for a more detailed overview of the hoofs because it was suspected that some of the tissue changes had started. The cows with confirmed tissue changes (assessed by an official employee who was trained for inspection and correction of hooves on the farms) on hoofs (sole ulcer, interdigital hyperplasia, dermatitis digitalis/interdigitalis) are named as "lesion" and no confirmed cows are named "non-lesion". Measurements of temperature of the coronary band were made according to Bobić et al. (2017a), as shown in Figure 1. For the analysis of thermal images and determining the temperature of the hoof's skin surface, FLIR software (7 FLIR and software systems, FLIR Systems Inc., Boston, USA) was used. For statistical analysis cows were divided into three classes depending on the parity: cows in first, second, and third and later parity. Furthermore, they were divided into three classes depending on the stage of lactation: ≤100 days, 101–200 days and >200 days in milk. The effect of parity and stage of lactation on hoof temperature was tested by least square analyses of variance using the PROC GLM procedure in SAS (SAS Institute Inc., 2000) separately for "lesion" and "non-lesion" cows. The significance of the differences between the parity and lactation stage groups was tested by Fisher test.

Results

Although an increase of temperature was recorded, the parity did not have a significant effect on temperature of the coronary band in the cows with confirmed lesions (Table 1). Regarding the stage of lactation there was a significant ($P<0.0001$) difference between lesion cows in first and second parity. For the cows without lesions the situations were quite different, because both, parity and stage of lactation had significant ($P<0.01$; $P<0.0001$) effects on the temperature of the CB.

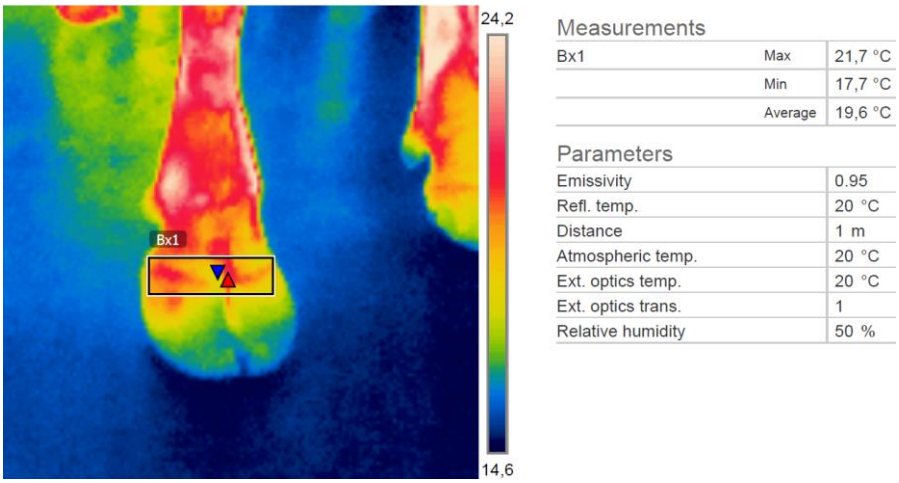

Figure 1. Thermal image of the hoof with corresponding measured values

Table 1. Least squares means (LSM) of coronary band (CB) temperature of the hoofs for cows with (lesion) and without (non-lesion) confirmed lesion

		Parity			Stage of lactation	
	Unit	Lesion	Non-lesion		Lesion	Non-lesion
1.	°C	24.67^{a}	23.7^{a}	I.	27.69^{a}	28.25^{a}
2.	°C	25.8^{a}	20.05^{b}	II.	25.6^{ab}	25.28^{ab}
3.	°C	26.56^{a}	21.18^{ab}	III.	24.23^{b}	21.46^{b}
P-value		NS	P<0.01	P-value	P<0.0001	P<0.0001

1. First parity; 2. Second parity; 3. Third and later parity; I. ≤100 days; II. 101–200 days; III. >200 days; ab - values marked with different letter differ significantly (P<0.01; P<0.0001); NS - not significant.

As shown in Figure 2. a, b, c in first parity the lesions were determined in 54% of the cows, in second in 78%, and in third and later parity group in 91%, respectively. According to stage of lactation, the highest percentage (88%) of cows with lesions was determined in group ≤100 days in milk, while in cows between 101 and 200 days in milk, 78% had lesions. The lowest percentage (58%) of the cows with lesions was determined in the group of cows over 200 days in milk (Figure 2. d, e, f).

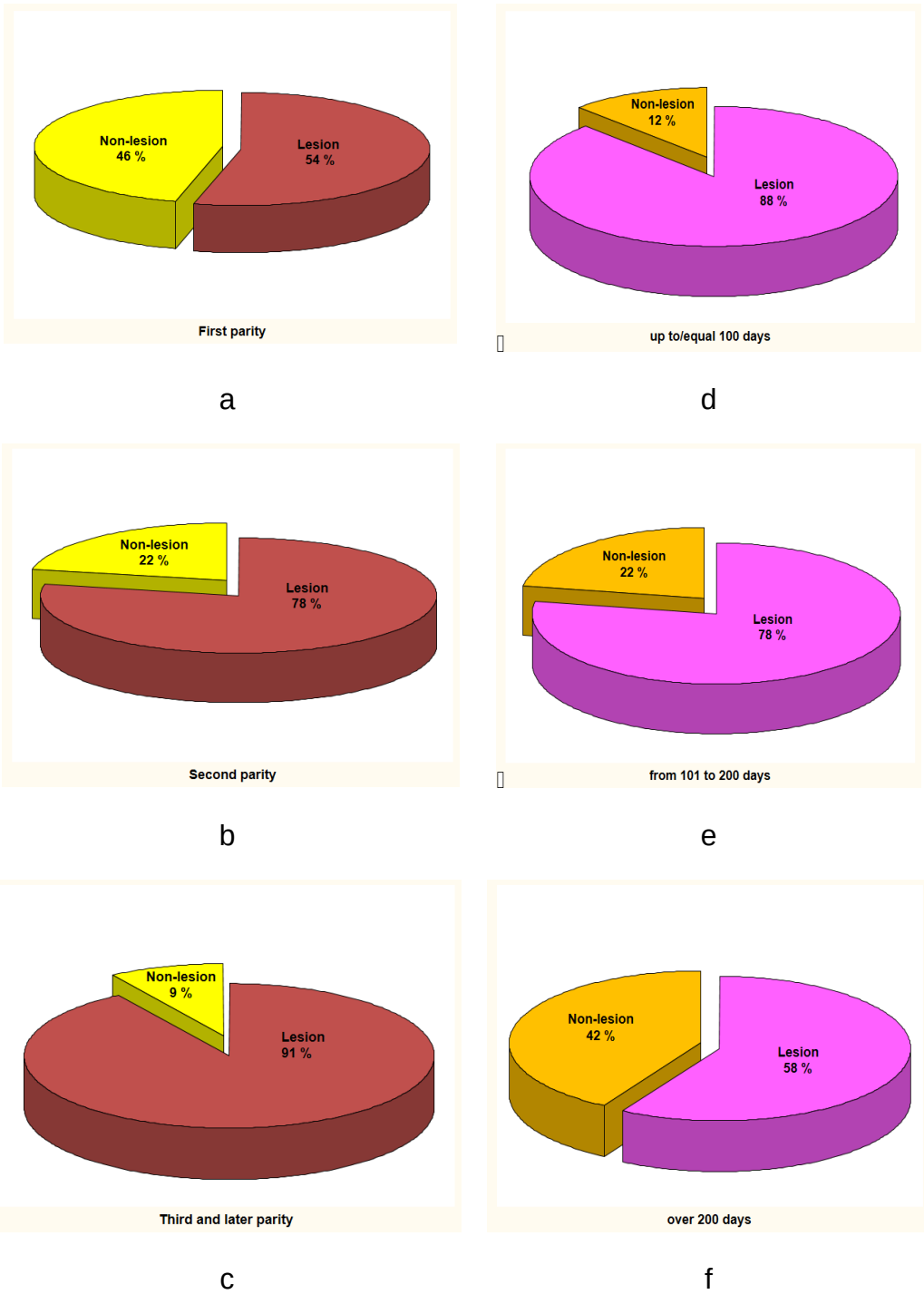

Figure 2. a, b, c, d, e, f. Distribution of the cows with non-lesion and lesion hoofs depending on parity and stage of lactation

Discussion

According to previous studies (Spire et al., 1999; Cockroft et al., 2000; Poikalainen et al., 2012) the body temperature and in particular, some of its parts, can be used as a good indicator in assessing the health and physiological status of the cows. The

temperature of the skin of dairy cows' legs detected with thermovision camera are affected by many factors, such as: environmental conditions (Landgraf et al., 2014), animal, dirtiness of the skin, stage of lactation (Alsaaod et al., 2015) and also presence or absence of the illnesses on the hoofs (Alsaaod et al., 2014). The application of thermography as stated by Alsaaod et al. (2015) has potentials for use in dairy farms to detect diseased hoofs at an earlier stage of illness. According to previous researches (Bobić et al., 2017a, b) there is over 60% (63 and 70%) chances of the positive finding of diseased hooves, using a TC in farm management. For possible prevention of lameness with a thermovision camera, is crucial to find the best time for the measuring the skin temperature on the hoofs, and early detection of the inflammatory changes, before lameness occurs. In this study it seems that cows are more susceptible to diseases (78 and 88%) at the beginning of the lactation (≤100 days and from 101 to 200 days), and also had higher temperature of the CB in comparison to cows which are more than 200 days in lactation. This agrees with results of the Nikkah et al. (2005) and Alsaaod and Büscher (2012) who determined significantly higher temperature of hoofs area in cows in earlier lactation (≤200 days in lactation) in comparison to cows in later lactation stage (>200 days). Furthermore, the difference in temperature of the CB depending on the parity in lesion cows was lower than in non-lesion cows. Same trend was observed depending on the lactation stage. Furthermore, the ambient temperature at the time of observation and recording of the cows should be taken into account. The metabolic changes and problems which occur in dairy cows in the first 200 days contribute more to rising of the risk for the lameness, and it seems that this period is critical moment to measure the CB temperature of the hoofs in dairy cows with thermovision camera and detection of the lesion cows before lameness occur.

Conclusions

The obtained results indicate that stage of lactation had a stronger effect on the tissue changes on hoofs than parity and consequently on the temperature of the coronary band. This knowledge is crucial when using thermovision cameras for detecting cows which are at risk of lameness.

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